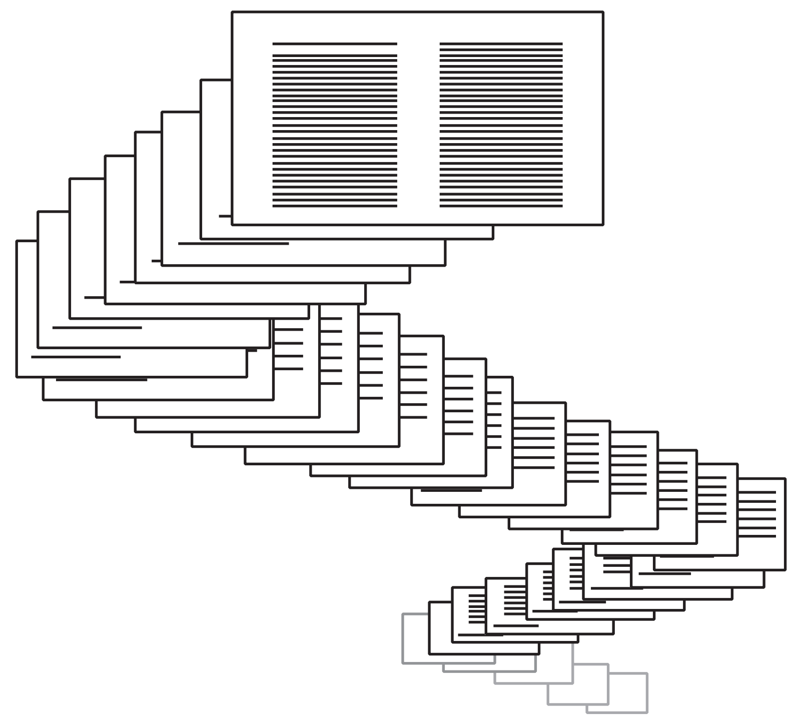
Eleven Chapters

in Other People's Books

Robert E. Horn



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1969
Focus:
Learner Controlled Instruction

by Robert E. Horn

A chapter *"*Experiment in Programmed Learning" in Runkel, Philip, Ed. (1969) *The Changing College Classroom*, Jossey-Bass

The Changing College Classroom

Robert E. Horn

Experiment in Programmed Learning

The descriptions in the 1965 Teachers College summer catalog were not much different from a thousand other course listings, but the twenty-five graduate students found themselves in a unique learning situation—a prepared environment containing twenty learning stations.[1] I greeted each student, asked him to fill out administrative forms, and invited him to have a look at the learning station area of the room. "You mean we just wander around until we find something we want to study?" was the usual question. "Yes. Here's a list of possible objectives; they might be of some use to you. The room will be open from eight in the morning to four in the afternoon every day. We will have a group meeting most days right after lunch." The stu-

[1] This experiment would not have taken place had it not been for the invaluable assistance, enthusiasm, and support given me by Philip Lange. I am indebted to Matthew Miles and Kenneth Herrold for valuable comments and advice.

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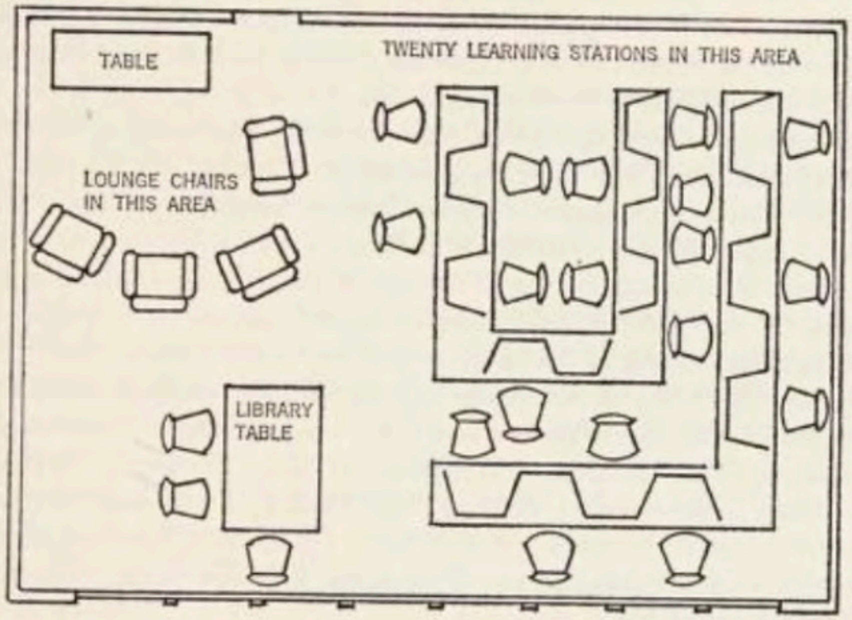
Columbia University

dents moved around the part of the room containing the learning stations while I watched from a lounge chair on the other side of the room. For a long time I had wanted to try out this kind of instructional systems design to see what kind of learning took place when students had substantial control over such factors as the amount of time they spent on various aspects of subject matter and the sequence in which they set up their own learning. I wanted to see what would happen when this self-directed study took place in an information environment specially designed for such study. When the experiment was over two weeks later, I was satisfied that this kind of instructional systems design had many advantages, over more conventional designs, for the educational needs of coming decades.

For several years I have taught courses in elementary and advanced programmed instruction, educational technology, and instructional systems design. I have become increasingly disturbed because the

THE INFORMATION ENVIRONMENT—FREE ACCESS LEARNING STATIONS

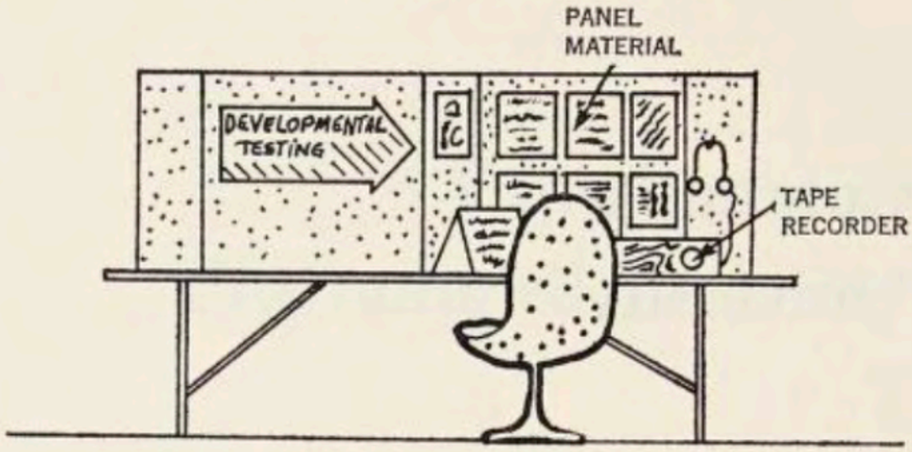
THIS ROOM WAS AN ORDINARY COLLEGE CLASSROOM ARRANGED LIKE THIS

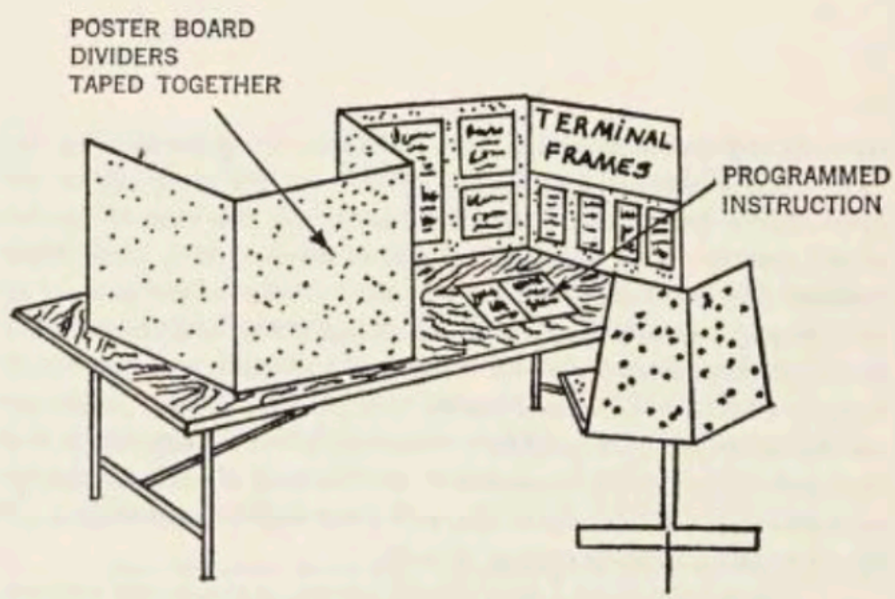


dents vary in age and ability, but also they differed widely in background, experience, and interests. Training directors from industry, free-lance writers, publishers, editors, college professors, high school administrators and teachers, and elementary school teachers were all in the same class. I had tried a number of conventional methods to individualize instruction, as well as some novel ones (Horn, 1964), but felt that I had not yet solved the problem of designing an instructional system that enabled each student to pursue his own learning path, to meet his own learning objectives.

With Michael Spock, director of the Children's Museum in Boston, I had been working on designs for museum exhibits and had explored the notion of informal learning—the learning that a person does when he does not have to (Horn and Spock, 1965). The museum display was impressive as a behavioral influence, the architecture of environment design that says to a person, "You can learn here and it will be fun." We had also been reviewing the information designs resulting from our experiment in student-controlled inquiry sequencing (Horn, 1964). I became again aware that a tremendous amount of

LEARNING STATION DESIGN FOR TWO-WEEK COURSE ON INSTRUCTIONAL SYSTEMS AND PROGRAMMED INSTRUCTION AT TEACHERS COLLEGE





courses were not being designed to meet the needs of all the students who took them. Everybody who took the course got the same sequence of lectures, assignments, and exercises, and yet, not only did the stu-

learning took place when students and others selected avocations and, with little or no help from an instructor, became expert in certain skills and absorbed a lot of information. In a preliminary functional analysis of the interactions between instructors and students, I had observed that the instructor too often acted as a transmitter of information obtainable elsewhere. Not only could the students read the same material approximately three times as fast as the instructor could say it but, if the instructor could spend that time discussing with students their individual learning problems, the gross effectiveness and efficiency of the teaching-learning situation could be increased substantially. These concerns suggested the possibility of building a learning information environment to incorporate these features of the teaching-learning situation. Of the twenty portable learning stations, sixteen were devoted to a particular aspect of the programmed instruction content, four were empty. The topics of the sixteen learning stations—each of which was furnished with five to twenty hours of materials—were: Instructional Systems, Task Analysis, Objectives, Writing Sequences, Writing Frames, Developmental Testing, Field Testing, Audiovisual Components I and II, Research, How to Keep Up to Date, Use in Schools, Use in Industry, Analysis and Evaluation, Behavior Study, Sequence Analysis, and Editing.

LEARNING STATIONS

The learning stations were set up in one half of the room; the other half contained tables and a circle of comfortable lounge chairs.

The stations were made of thirty-by-forty-inch matting board, the kind used in picture framing. Each piece was scored with a razor blade or knife so it could be folded in two, making dimensions of twenty by thirty inches. Masking tape held this fold together at the corners and the five pieces for each station were put together end to end with masking tape on both sides. The pictures, articles, or magazines selected were glued to the matting board. For the titles on the learning stations, we used transfer letters available in most art stores. Every attempt was made, with the use of many museum exhibit and display techniques, to make the learning stations attractive. At each station we used a variety of notebooks and library file boxes containing file folders. Three stations held tape recorders for audio material. I tore out chapters and paragraphs from my own books and ruthlessly cut

material in an attempt to make the contents relevant, excellent, and not redundant.

Since each of the twenty stations was devoted to a different aspect of the subject, the student had to make a conscious decision about what to study next. In fact, he had to get up and move to some other place to study it. This element of the design is important because one of the intentional effects of the course was the student's increased awareness that he was making learning decisions about time and sequence. Each station was fully stocked with material pertinent to one broad aspect of the subject. All material was in one place. Duplication was avoided. This gave the student who wanted, for example, to study the analysis and evaluation of programmed instruction a chance to sit in one place and see the reviews of published programs, various criteria for evaluating programmed instruction, and theoretical and practical articles on the notions of analysis and evaluation. Each station contained up-to-date material. Often it contained prepublication drafts and small circulation technical reports of research completed or in progress. This material provided something of a surprise to many graduate students who were often dependent only on published materials which frequently reach press several years after the work has been done. Many of the stations provided feedback to the students in the form of self-tests and programmed instruction sequences.

One of the basic concerns in constructing these stations was to give students random access to the information they sought. A lecturer using printed materials generally imposes his own choice of order in presenting those materials to his students. If the material were arranged so that it was easily accessible, the individual student would determine a rational sequence of study. This was true of the macrosequence of broad paths of inquiry; the microsequence of printed paragraphs was not controlled. The students used the learning station environment voluntarily. No time or sequence constraints were imposed; there was no need to ask permission to come or go; there was no constraint to study when the student did not wish to. The course was not graded but self-evaluated. To provide the security and lack of tension that good learning requires, students were assured that their goals were of paramount importance and that they would receive only a pass or fail on their university reports.

Each learner had substantial control over his selection of goals,

broad categories: one pertaining to the attitudinal and interpersonal characteristics of his relationship with his learning environment; the other pertaining to the content of the course. For example, consider two persons studying the same subject. One has been given a research paper to read. The other has decided that he is interested in the research paper. Both have interacted with the same research paper, but one has followed directions, the other has made his own decision about learning. We can expand our field of vision from the reading of one research paper to all the responses a student makes in a course or, for that matter, in his entire schooling, and ask what proportion of the responses he makes can be considered as following directions and what proportion as setting his own goals and receiving the consequences of such practice. It is clear that a student needs to practice both. In our educational process we have overemphasized the practice in following directions. Too often our education system produces docile sheep whom we, as teachers, managers, or citizens, then regard as lacking in initiative, unable to be leaders, uncreative, and whom our sociologists, psychiatrists, and social critics find "full of feelings of helplessness—directionless, alienated."

The designer of instructional systems must consider these matters as he prepares the course. I made several analyses to guide my designs for the instruction and for my behavior during the workshops. First, I prepared an analysis of what was to be incorporated into the learning stations. This analysis was then translated into a set of possible objectives for the students to follow. The introduction to the list of objectives stated: "The title *Possible Objectives* is intended to suggest that not all of these objectives may be *your* goals. . . . One of the important things we do every day in our lives is to select goals for ourselves. The conduct of this course assumes that this goal-setting process will continue in the classroom. Thus, it is entirely up to you to decide what aspects of programmed instruction and instructional systems design you want to study during this course. These possible objectives are . . . merely to assist you in formulating your goals explicitly."

Second, I made an analysis of what learning decisions have to be made repeatedly in the course of an instructional period. I assumed that somebody has to make decisions about objectives, time, sequence, plans, resources, and what to do with the information provided. I also assumed that selecting goals for oneself cannot be taught when the instructor makes every major decision; that allocation of time and de-

both short and long term. Students were told, at the beginning of the course, that they would be in complete charge of the learning process. They were free to change their objectives at any time. They were encouraged to be explicit about their objectives by writing them down on log sheets and were encouraged by the instructor to discuss goal setting. Each learner had substantial control over the time he spent on each topic. The only time constraints were the hours when the room was open. Students could stop, rest, relax, get a cup of coffee, talk with one another or with the instructor at any time they chose. While each learner had substantial control over the sequence of learning and could follow his own path of inquiry, he could ask the instructor for advice on recommended sequences. Because the materials were arranged in small, random access chunks, the student had a better chance to control the sequence than he normally had when sitting with a couple of books. Each learner had substantial control over the evaluation process. Since he had selected the goals, the learner could, if he wished, evaluate himself in terms of how well he had met these self-imposed goals. He could ask the instructor for an evaluation of his work or for an opinion on a particular topic.

The sequence of steps to be taken by the student could be decided by the instructor or by each student himself. These decisions might be based on the traditional variables to which educators pay attention, such as age, IQ, reading level, aptitude, and learning rates. However, I feel that these are not the relevant individual differences that the instructional designer must take into account for adults. When students are tested according to traditional variables, it is generally the instructor who decides what the student's learning design shall be. The important variables are the differences in learning goals, in background and experience, and in learning style preferences. When this less conventional set of variables is used for testing, it is the learner, who knows most about them, who makes the important decisions about learning designs. Pretesting as a way of allocating each student's curriculum appears to be expensive and time-consuming. The student can do the job more quickly and precisely.

OBJECTIVES AND GOALS

Learning consists of making responses: one reads, tries to do something, practices, reviews, organizes, analyzes, and so on. The responses that a student makes during a course can be analyzed into two

cisions about the sequence for learning cannot be taught through lectures and assignments by the instructor; and that the evaluation of complex issues cannot be learned if the instructor predigests the evaluation. My analysis of learning decisions began with the student seeking acceptable goals or objectives. The instructor can help the student draw out objectives from himself; he cannot accept objectives for the student. The information needed for formulating objectives comes chiefly from the student himself through the instructor's asking such questions as: what does this student want to be able to do? What must the student be able to do? What does the student think he can accomplish? What are the possible objectives?

The student must allocate his time among his several objectives within the course and may change the proportional allocation. The necessary information about how long it takes to do various things described at the learning stations can be obtained partly from the instructor, partly from the labels on the learning stations, and partly from the student himself. The student also decides upon the sequence of activities and may alter it at will. The instructor may recommend a sequence if asked or may indicate prerequisites where there is a best sequence. Where applicable, prerequisites are listed at learning stations. Decisions about skills and information provoke questions such as: Shall I just scan this? Shall I just read this information? Shall I try to remember this? Should I learn how to do this? Shall I make notes for reference? Shall I get an outside evaluation of my accomplishment? The decisions must almost always be the student's, though the instructor may be consulted. The suitability of the activities consequent to these decisions, too, can best be assessed by the student.

Third, I made an analysis to help guide the conduct of the course. This was a set of predictions of students' expectations for graduate courses at the college, how our course would contradict these expectations, and what behavior we could predict because of the contradictions. The analysis is displayed in Table 1. Notice that in the left-hand column the role expectations are designated as *initial state* and the right-hand column, *optimal state.* I expected some students to enter the course with optimal state expectations and others to achieve them in a few minutes. Some students would enter the course with strongly ingrained initial state expectations and move toward optimal state expectations and behavior only with great difficulty. This role-expectation analysis gave several insights into student behavior and

how I might guide behavioral change in my interactions with the students. It enabled me to anticipate pleas of helplessness, requests for direction, demands for guidance and approval of goals, and to plan my responses to these reactions. Implicit in this analysis is the assumption that I would not reward docile dependence on the instructor for guidance and direction nor would I reward inadequate preparation before consultation with the instructor. By giving them attention and suggestions, I would reward students who asked intelligent questions, who had made prior decisions and wanted to discuss a course of study, who had done inquiry work at the stations.

INFORMATION AND IMPRESSIONS

Every teaching-learning situation, even the most conventional lecture, is an experiment. The hyothesis of any teaching-learning experiment is that an input of instruction will produce an output in terms of changes in students' behavior. However, it is not possible to assess everything one might wish in one course; my choice of variables was based on their relationship to the assumptions of the design. Thus, I attempted to answer questions about individual differences in background, interests, and learning styles of our students. I collected information on what they thought their learning goals would be and how these goals changed while they were in the learning station environment. In addition I obtained anecdotes about what the students felt about the learning experiences. Some summaries appear below.

Each person studying a subject has a particular point of view different from that of other persons studying the same subject, therefore different students will have different learning goals within the same subject. In most instructor-controlled courses, a student finds that some of his learning goals are met and some are not because the instructor controls the sequence and amount of time spent on each aspect of the subject. Having decided to turn over to the students the decisions on sequence and time, I wanted to find out exactly what goals they had. On the first morning of the course I collected data on the students' goals, using a form that asked the student to allocate the available fifty hours among twenty-three topics I suggested, and to write in other topics if necessary. There was no one topic in which all of the students were interested. But every one of the twenty-three received an allocation of time from at least one student. One item, How do you test a program?, interested nine of the students; the amount of

Role-Expectations of Student for Himself, Instructor, and Peers: Initial State	*Communication in Work Conference to Contradict These Role-Expectations*
Instructor sets goals and proficiency level. Both I and the group will accept these goals and proficiency levels. He is not interested in my goals.	Instructor provides only a list of possible goals and indicates that learners must choose proficiency level. Only pass or fail grades will be given.
Instructor will determine each learning activity (duration, sequence, and type of participation). Both I and the group will do what is required and assigned. I will contribute what I can.	Instructor indicates that duration, sequences, and type of participation are up to the student. Learning stations provide resources.
Instructor will be primary information transmitter. Group will act as information receivers. I will listen and take notes.	Learning stations are primary information transmitters.
Instructor will be primary interpreter and evaluator of subject. Group may question his evaluation to some extent.	Instructor indicates that he expects each learner to evaluate and interpret subject matter for himself.
Instructor will give me some directions and advice on personal goals and learning problems and will cut me off when I have taken too much time. Group will tolerate occasional questions during discussion. I will make requests when I feel it appropriate, but there will not be time for much of this.	Instructor will indicate that all of his time will be available for personal consulting with individual students.
Instructor is not interested in my evaluations of the course and of his instruction.[4] Group will generally not criticize the instructor—or compliment him. I will avoid making my feelings known.	Instructor seeks student-evaluation of the course, of materials, and of himself.
Instructor does not care if members of the class help each other. Group is interested in themselves, not in helping. I do not expect to give or receive much help from other members of the class.	Instructor will provide class with a profile of resources within the class so that help may be asked. Indicates general approval of helping each other.
Instructor will discuss subject matter content questions when asked in class discussion. Group will tolerate questions even if they are not interested in them. I may ask questions on content and will tolerate other questions.	Instructor indicates that he will answer content questions in the group setting only if all members are interested in the question and all have used the prerequisite learning stations.
Instructor will answer any subject matter question I put to him personally.	Instructor indicates that he will answer only those questions which are not answered by the learning station materials.

Student's Reaction to this Contradiction of his Expectations	*Instructor's Response to Student's Reaction*	*Optimal State of Student's Role-Expectations for Course*
Silent frustration. Request for direction. Pleas of helplessness. Demands for guidance, for approval of goals.	Points out resources for choice. Offers to help in evaluating goals.	I must make final decisions on my goals and level of proficiency. Instructor might help after I have done my job.
Vague, aimless wandering. Exploration. Curiosity.	Encouragement, counseling and help in identifying goals.	I must make my own choices on duration, sequence, and type of participation. Instructor may help me clarify my choices.
Requests information which is in learning station.	Learner told to consult appropriate station.	I must actively seek out information, decide what to learn, and where it is.
"Tell me what to think," requests. Dogmatic stances.	What do you think? How do you make an evaluation?	I am able to make my own interpretations and evaluations.
Apologetic requests. Anxiety over taking up too much of the instructor's time.	Consults. Gives advice on learning problems, feedback on how learner is progressing.	Instructor is a resource for advice on learning problems. I can get feedback. I have learned how to use this resource.
Suspicion, disbelief, some criticism.	Actively seeks evaluation, changes behavior and class structure on the basis of student's criticism.	I will make my feelings known to the instructor because he is interested in them and will change his behavior on the basis of what I say.
Tentative groups form. Suspicion, disbelief. Some help given and received.	Encourages groups to form and suggest specific forms of cooperation.	I expect to give and receive help from other members of the class.
Some student attempts to engage class in subject matter discussion.	Maintain stance. Gives answer if all are interested.	Instructor will not discuss subject matter content questions unless whole class desires it and all are prepared.
Frustration. Requests for help.	Maintain stance.	I can use the learning stations first, and use the time I have with the instructor better.

time they wanted spent on it varied from two to five hours. One student wanted to spend twenty hours examining the best programmed instruction published. One wanted to spend fourteen hours preparing transparencies and overlays. Four wanted to spend from fourteen to twenty-four hours writing their own programs. We can infer from these data some of the reasons we see so many bored faces in our classrooms. I suspect that in any course the results might be similar. The question that faces the instructor—the instructional systems designer—is how to arrange conditions and environment so that students can learn what they are interested in learning.

By the time students are adults their learning goals differ and so do their learning styles. While I was collecting the information on the learning goals of the students I also obtained data on how they would like to have the course arranged, and discovered that two students did not want to speak with the instructor at all. Others, upon learning that the instructor had a total of fifty hours to distribute among twenty students, wanted ten of those fifty hours for personal tutoring. Especially noticeable was the lack of interest students had in talking to one another; only three allotted any time to discussions with others; only two indicated a willingness to work on a group project.

STUDENT REACTION

The only assignment students were given during the course was to write an evaluation of the experience of using the learning stations. The following excerpts from the papers of five students have been chosen to give some of the flavor of the course as they experienced it.

Student A: "The instructor was very cordial but did not tell any student just where he would begin visiting the stations. This was strange, I guess, being used to the conventional type of classroom procedure on the first day of school. After a few minutes of exploring and observing, I soon decided each person began wherever he desired. I do feel that my major objectives were accomplished. In a few days I soon realized how much a person can learn through self-instruction."

Student B: "In the workshop I stumbled and groped. I knew I needed more background, I knew I wanted to write a program, but the first day I felt the instructor was groping, too. Since I had never attended a workshop before, I had no *mind-set* for procedure or expectation. I had only a desire to solve the need I felt for better materials. It took me a little while to adjust from a mind-set calling for a lecture

type of class to the format of the workshop. The informality of 'what does the group want to do?' approach and the nervous mannerisms of the instructor caused an unpleasant reaction at first. I wanted direction. I wanted the security of a planned program—a plan I could recognize. Never one to give up easily, I joined the clamor for an overview lecture and then went to the writing sequence booth. My first visit to the sequence booth was frustrating and the overview lecture was a repetition of what I already knew (okay, so you were right about the *lecture mind-set*). I reread the objectives of the course, got lost in the *givens,* got confused in the sequences, and determined that 'I paid my money and, by golly, I'm going to get something more than frustration out of this workshop!' I began to read with a vengeance at each learning station . . ."

Student C: "My chief impression from the learning station sessions is one of awe. Knowing how much there is to know about programmed instruction is a lesson in itself. Had the class been faced with a stack of books and papers to inspect, the experience undoubtedly would have been quite different. The books would have looked like nothing more than books—a forest of verbiage to plow through—a literary obstacle to be hurdled, and the impression would have been the usual one experienced by over-assigned students: despair . . . not awe. But the logical presorting of ideas by topic converted the assignment into a challenge. Right there before his eyes, the student could view the whole field of knowledge, grasp the full scope of how much he could learn and, very helpfully to have this happen so early in the course, appreciate keenly that he could not humanly learn everything offered in each station and had to choose a specialty, ultimately, if not at once. Then, with a special objective selected, the challenge remained. The availability of the station material throughout the day represented a strong inducement to continue poring over the subject for hours. My only regret now is that I'll probably never again enjoy an opportunity to digest such a complete sampling . . ."

Student D: "I was completely frightened the first day of the course. The question sheets were so hurriedly passed out and collected and not explained thoroughly. I also had a feeling during the first few days that I had made a terrible mistake in taking the course because I suspected that all of the people in the class had more experience than I. I suppose that this was because we didn't have time to become well acquainted on the first day and were secluded behind a station the

rest of the time. I have never been in a class where *action* research was going on. I feel that the instructors in the course are attempting to find better ways of teaching this course. I have claimed to be an advocate of this type of experimenting. However, I was astonished when I found myself whining to my husband and others that I wasn't getting any attention. I complained at various times that I didn't know what I was doing, that I didn't have enough of a background to be left on my own devices like this, and also complaining that I had not been forewarned that the class was going to be taught in this manner. This complaining seems peculiar because I was actually very happy each morning as I settled down to reading and taking notes as I saw fit. The complaining also seems peculiar because I never felt that I had completed what I had planned for the day."

Student E: "Interaction with the instructor was crucial to me when I was in the early phases of getting acquainted with the basic concepts in the field. This is the time when possible confusion, lack of background, or just plain not understanding an item can reduce motivation a great deal. Ready access to the instructor enabled me to maintain myself on a continuous reinforcement schedule, which, as Amsel says, is important in early learning stages. I could get a point cleared up or receive confirmation of a discrimination I had made and to this, I attribute my desire to go on and on . . . As I thought about the effect of the present learning station system, I attempted to phrase this question to myself: 'How is it different from an ordinary library? What's so different about it?' In order of discrimination, this is what came out: (1) It offers the basic concepts, research data, the research bibliography, etc., in readily available form. One would have to spend time searching in the stacks, walking to and from the library, waiting on reserved book lines, etc. To me ready access is a powerful reinforcer. (2) It enables a neophyte to form a set-of-field by simply viewing the various stations as a logical subsystem of the total system, which, even though imposed and, therefore, unreal to an extent, enables one to guide oneself through moving from simple whole to complex wholes . . . To try and say it another way: a learner comes with a unique combination of knowledge, response styles, propensities, interests, etc. Random-access in the learning station system would appear to make the person and the material an intrinsic programmed self-controlled system responding to (computer style) the information

and the choosing of the next step as it seems most fitting at that time, at that level of sophistication."

INSTRUCTOR REACTION

My dominant reaction to the workshop experience was that I had worked at the top of my capacity every minute. By changing my role from that of lecturer, or primary information transmitter, to that of consultant, I felt that what I said to each individual who came over to me for a chat was relevant to his concerns at the moment. I was free from the anxiety I always feel in lecturing; namely, that half of the students either are not listening because they already know the subject, or that they are missing my carefully phrased discriminations. In the workshop situation with the learning stations, I felt that, when a student came to me with a problem or a question, I could put my full effort into helping him—without worrying that twenty or more students were sitting around wasting their time.

My second satisfaction was that I had made the best use of my limited time, money, and materials. On other occasions, I had spent most of my preparation time producing lectures or laboratory exercises that contained, as in all fields, the work of many researchers before me. Much of what I said in a lecture had been written down earlier by somebody else. In allocating my time before the workshop to selecting and organizing what had already been done in the field, I made a system that provided better access to more material for more students.

No longer an information transmitter, I could get a much better picture of how the individual students were doing. When they came to me with problems, questions, and requests for evaluation, I had time to find out precisely what their difficulties were and how I could help. The evaluation in depth of these personal encounters was far more helpful to the student than the usual evaluation of a symbol on a report card. Even though we had set up a pass-fail system for the course, I felt that, because of these meetings with the students, I could have given more precise grades than I could under conventional testing methods. These meetings with students also provided an insight into the defects of the instructional materials they were using. I can't imagine how I could have learned so much in so short a time by any other method. It is hard to imagine counting on a mere library list again to produce predictable behavior changes.

The biggest differences I noted among the students was in their ability to use me as a resource. Some were very skilled at it; others were poor. Some came with specific questions and had a clear idea of what they wanted me to do; others would come over, talk about themselves, and appear to be asking me to relieve some anxiety they had in making decisions. I felt that practice, regardless of the level of skill, in using some person as a learning resource was needed. I might mention that I had to learn to be a consultant in this kind of situation. During the first afternoon of the workshop, I sat waiting for students to come over and ask me questions. None did. I sat there with nothing to do. I felt strong impulses to go over to the learning station area and look over shoulders. There they were, studying hard, and I wanted to interrupt them. I wanted to know what they were doing. I felt that the workshop was out of my control. I resisted the impulse and found something to read, but not before pondering the thought that perhaps we instructors often overrate our own importance in the minute-to-minute control of student behavior. Nevertheless, I did not have to wait long before the stream of visitors started, and kept on uninterrupted, for the rest of the workshop.

Undoubtedly I would do it again. My dominant feeling, supplied by the learner protocols and my own observations, was that the learning station design, coupled with self-sequencing, did help students achieve their own objectives. Approximately 75 per cent of the students gave unsolicited statements to the effect that they would build such learning stations in their own classrooms. No investigation a year later was made to see if they carried out their intentions.

I have already mentioned that two classes used the learning stations. One class, according to the catalog, met for two weeks from 9:00 A.M. to 4:00 P.M. The other class started on the same day and was scheduled to meet for six weeks (from 8:00 A.M. to 9:00 A.M.). During the first two weeks of this latter course, students were told that they could use the learning stations as much as they wished. There was a total of nine required hours. A tally showed that these students actually used the learning stations an average of twenty-one hours during the two-week period. Their use ranged from twelve hours to forty hours. In other workshops that I have conducted, students would arrive in the morning and stand and talk for a long time before beginning work. One of the striking things about this workshop was the

typical behavior of the students upon entering the room: they immediately began work, although half of the room had been furnished especially for informal conversation. I concluded that, if inquiry results in readily obtained answers, a high and steady rate of inquiry takes place. This is an interesting hypothesis for further research.

Based on my experiences with previous workshops of similar duration, I can say that I was impressed by the high quality of the programmed instruction units written in this setting as compared with previous settings, although fewer students actually chose to write sequences (in other courses, writing sequences had been required). Perhaps the lower quality in previous courses was a result of our requiring the writing before the learners felt ready; perhaps not. I do not know.

The possibility of creative behavior did not occur to me until it happened. At least two students came to me with innovative programmed instruction techniques during the course of the workshop. In no previous course had I encountered such innovation.

I will change a number of my operating procedures the next time I use the learning stations for a course. The lack of pretests and posttests would not prevent me from using the same design again, but it would definitely improve the overall design to include them. I would also devise self-tests for each of the learning stations. I used a few this time; next time I would want more. I would also change the printed sheet of possible objectives to enable neophytes to make better judgments about their time. I feel now that the student should have access to a chart listing objectives, minimum acceptable standards, and the time he could expect to spend in achieving the objectives. I would also like to relate the objectives to specific secondary objectives and suggested learning materials. There was little unanimity among the students when I asked what topics for learning stations they would suggest I add to the existing collection. I would definitely add one called the [*Robert*] *Horn Station*. Late in the second week, one student suggested it. He said he had noticed papers of mine scattered throughout the learning stations, but did not know whether he had read all of them. I recognized a very natural desire on the part of students to want to know, early in a course, about that stranger called the teacher. Finally, I would rent an office copier for students to copy pages of the materials. If there was one universal complaint, it was about the lack

of such equipment. It is an interesting complaint: it means that we had generated a publishing need; it means that students are affluent enough to trade money for time in note-taking.

DEDUCTIONS AND IMPLICATIONS

It is not enough to put students, a teacher, and some books into a room and hope for the best. Nor is it enough, when trying out some innovation in instruction, to consider only one factor. Too often I read reports of experiments that pay attention to only one factor; they change the grading system or try to alter the norms or alter the objectives or change the information environment. Seldom do we find attention given simultaneously to all of these factors in an instructional systems design. In designing or evaluating any instructional system, one must examine such variables as: the characteristics of the students, their interests and goals as well as their background and abilities; the availability and design of the information environment; the ability of the instructor and the information environment to provide feedback to the students; the properties of the interpersonal associations among students and instructors; the behavioral outcomes of the instruction period; the allocation of decision-making responsibilities among students and faculty; the reward system for the students and for the instructor; the role-expectations of the instructor and the learners; the resources of time, material, space, and money. Change any one of these and you change important characteristics of the system.

The self-sequencing learning station design certainly cannot be applied in every course. Students also need some practice in following directions, listening to lectures and going to the library. However, I do feel that the ideas can be applied to the design of instructional resource centers in all of the grades, elementary school through professional training, as well as in adult education, management training, and skill centers for industry training departments. An interesting possibility for higher education is the permanent establishment, supported by an academic department, of a room like mine in which all introductory courses are taught. Different advanced courses could have different prerequisites, which could be acquired according to the student's choice in the learning environment. Few professors seem to like to teach introductory courses anyway. So, it would appear that the wedge for innovation might be there.

For me, the work with this system brought into focus several

important areas for further study. One is the problem of designing information specifically for students who are engaged in the process of self-instruction, and who are in charge of their own goal-setting and decision-making. Another is the problem of teaching people to manage their own learning. Finally, the experience of trying to design a total system that was novel from start to finish has suggested that I explore other combinations of objectives, social systems, information environments, and decision-making allocations. There are many other such designs, some novel and some which have been tried out, which should be implemented more widely.

1999
Information Design as an Emerging Profesion

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Information Design: Emergence of a New Profession

Robert E. Horn

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Egyptian scribes sat every day in the marketplace and wrote hieroglyphic letters, reports, memos, and proposals for their clients. At least since then, the business of assisting others to make their communications more effective has flourished. Specialists in communication already abound in our society: ghost writers, technical writers, advertising writers and art directors, public relations writers, and marketing consultants are only the most obvious ones. In any field of human endeavor there is a process of, first, specialization and, then, increasing professionalization. Information design is the most recent manifestation of the age-old profession of communications assistance.

What Is Information Design?

Information design is defined as the art and science of preparing information so that it can be used by human beings with efficiency and effectiveness. Its primary objectives are

To develop documents that are comprehensible, rapidly and accurately retrievable, and easy to translate into effective action.

To design interactions with equipment that are easy, natural, and as pleasant as possible. This involves solving many of the problems in the design of the humanñcomputer interface.

To enable people to find their way around in three-dimensional space with comfort and easeóespecially urban space, but also, given recent developments, virtual space).

The values that distinguish information design from other kinds of design are efficiency and effectiveness at accomplishing the communicative purpose.

Need for Information Design

Why has information design emerged as a profession? First, managing information in our complex modern society requires sophisticated computing and communication devices and networks that operate with ever-increasing efficiency and effectiveness. Simply storing large amounts of information on computers and retrieving it does not solve our information needs. In fact, gigantic storehouses of information overload us with too much information and burden us with navigational problems that have sometimes make us feel that we are ìlost in cyberspace.î What we need is not more information but the ability to present the right information to the right people at the right time in the most effective and efficient form.

The second factor behind the recent push for the professionalization of information design is the increasing cost of management, technical, and professional time. Much of what most managers and technical professionals do every day is process information. If their information is poorly designed, they operate inefficiently and their organizations are not as effective as they might be. I once hired a secretary who had previously worked as one of four secretaries to a IBM vice president. Three of the secretaries were kept busy full time just summarizing the information coming into the office so the vice president could use it.

Information Design: Not an Integrated Profession

Information design is not as yet a fully integrated profession. Its practitioners have quite different views of the professionóeven different names for it. In newspaper and magazines it is called information graphics; in business itís presentation graphics or business graphics; and in science, itís known as scientific visualization. Computer engineers refer to interface design, while conference facilitators use the term graphic recording, and architects talk about signage or wayfinding. Graphic designers just call it design. While these practitioners no doubt have distinct interests that might warrant different names, many of their core concerns and practices are similar. The different terms simply indicate that information design is still mostly characterized by separate groups that have little or no contact with each other. Even so, there is undoubtedly an increasing tendency to march under the new banner of information design. This book is an example of that tendency. Moreover, in

the last decade, a number of design and consulting companies have begun to assemble their marketing messages around the concept of information design.

History of Information Design

It is beyond the scope of this chapter to trace the history of the information design movement in each of the professions mentioned above. Nonetheless, we can look at the history of information design as a profession in itself by considering some of those who contributed to its development (see Figure 2.1).

Inventors

One of the unusual aspects of information design as a profession is that we can identify many of those who invented particular classes of communication units (e.g., bar charts, pie charts, or time lines). There are towering figures in the history of information design invention and use. William Playfair, who lived at the time of the American Revolution, invented several major types of graphs and charts and popularized them use through his writings on political and economic topics. In addition to her contributions to medicine, Florence Nightingale is credited with inventing new types of statistical graphs and being one of the first to use information design in a public policy report, a massive 800-page document on hospital administration she prepared for Prime Minister Palmerston during the Crimean War (Cohen 1984). Although Michael George Muhall invented pictorial statistics just before the turn of the century, it was Otto Neurath, the Austrian social scientist, who developed a methodology for displaying them effectively (1973). David Sibbet (1980) has devised a set of techniques for graphically recording the process of group dynamics as they develop during a meeting. James Beniger and Dorothy Robyn (1978) provide a list of the inventors of quantitative charts, and H. G. Funkhouser (1938) usefully summarizes the early history of statistical graphics. I devote a chapter of Visual Language to the history of these innovations (Horn 1998).

Systematizers and Analysts

The systematizers have tried to bring all the pieces of the graphic language together to analyze them from a particular point of view. Jacques Bertin developed a comprehensive semiotic analysis of large portions of information design in his Semiology of Graphics (1983). Another early pioneer in this areas was Gui Bonsiepe (1966), whose early studies demonstrated that the visual language of graphics has analogues to many traditional rhetorical devices. Scott McCloudís Understanding Comics (1993) and Will Eisnerís Comics and Sequential Art (1985) are excellent analyses of one ìdialectî of visual language, the comic book. William Bowman (1968) produced an important early taxonomy of graphic communication, while Michael Twyman (1973) has provided an important analysis of how many types of static information design direct eye movement. My own book, Mapping Hypertext (1989), is not only an introduction to the world of on-line applications for information design but also (in its three central chapters) an overview of the structured analysis of subject matters and structured writing (see below).

Universalists

From time to time, individuals have hoped that purely visual communication, without the use of words, could become an international auxiliary language. A purely iconic language could substitute in certain situations, such as travel, for normal spoken language. In the optimistic era that followed World War II, the movement for iconic language attracted advocates like the eminent anthropologist Margaret Mead and her principal graphic-language compatriot, Rudolf Modley (1952). E. K. Bliss (1965), who developed an enormous and extremely clever iconic language of upwards of ten thousand symbols, was a prolific inventor and supporter of universalism. Like Mead, Modley, and Neurath, Bliss wanted to devise a purely iconic common language to free humanity from the tower of Babel created by its thousands of spoken languages. Purely iconic languages do not usually catch on, however, except in the field of transportation, which now uses internationally recognized symbols for all aspects of transportation and travel.

Collectors

Once any profession starts to grow, writers and publishers bring out reference books about it. Information design has its share of these. Among the more interesting, from a systematic point of view, is that of Henry Dreyfus (1984), who collected all the specialized icons from several dozen fields and incorporated them into a still-valuable reference book. Thompson and Davenport (1980)

put together an engaging visual dictionary of the images and metaphors found in contemporary advertising.

Writers of Instruction Manuals

Once a profession thinks it knows something that others do not know, a spate of how-to books appears. At Stanford University, Robert McKim (1972, 1990) pioneered in demonstrating that visual thinking is not solely a means of artistic expression but is also a powerful tool for problem solving in many professions. Stephen Kosslynís recent book on designing graphs and charts (1994) is a good example of a practical information design instruction manual. Gene Zelazny (1991) has written a similar book on business charts. Gary Gloverís introduction to the new field of clip art (1994) will enable many more people to use icons and illustrations in their information design. A book by William Horton on icon design (1994) is another excellent example of an instruction manual on a limited topic.

Aestheticians

Information design has great variability in style and quality, which often affects its usefulness to researchers concerned about issues of precision and clarity. Foremost among the aestheticians is Edward Tufte, whose concepts of data-to-ink ratio and chartjunk stand as enduring signposts in the skillful and graceful use of visual language. His three books, The Visual Display of Quantitative Information (1983), Envisioning Information (1990), and Visual Explanations (1997), have provided the field of information design with pioneering studies in how communication can be both beautiful and useful.

Popularizers

In recent decades, magazines and newspapers have been leaders in the popularization of information design. Stephen Bakerís (1961) book, Visual Persuasion, is an extraordinary window into methods advertising designers have long known about and practiced to make information attractive and persuasive. Nigel Holmes, longtime art director at Time, is an acknowledged teacher and pioneer in this area. He recognized, in particular, how design attractiveness affects whether readers will actually read and use information. Recently he described these ìinfotainmentî values in several books (Holmes 1984, 1991, 1993). David Macaulay ís The Way Things Work (1988) is another brilliant example of information design at work. We must also credit Richard Saul Wurman with raising public awareness of the importance of information design in his books, Information Anxiety (1989) and Follow the Yellow Brick Road: Learning to Give, Take and Use Instructions (1992).

Researchers

Research on communication, education, learning, human factors in technology, computer interface design, and perception all bear on the use of information design. However, most of the research does not use that term, even as an indexing category. To locate citations relevant to information design on research databases, therefore, we have to check many other keywords. But, as information designers begin to bring this research together, they can build on such firm foundations as the work of William Cleveland (1985), who has made important discoveries in the field of understanding quantitative graphics and charts. The research in structured writing (summarized in Horn 1993) is another area that is providing more secure foundations. Excellent summaries of the research on diagrams and other methods of presenting information graphically can be found in Winn (1982, 1990) and Horton (1991).

The British Information Design Society

In the history of information design a unique place must be reserved for the Information Design Society. As far as I can tell, this group invented and popularized the term information design. Its conferences have brought together users from several disciplines: design practitioners, researchers in psychology and education, computer graphics specialists, and teachers. Many practitioners of information design in the United States are members of this organization, as there is no comparable association in their own country. The societyís Information Design Journal, currently edited by Paul Stiff, has been a major source of coherence for development of the profession. Great Britain has also led the United States in the development of interdisciplinary university programs in information design. The program at the Department of Typographic and Graphic Communication at Reading University, chaired by Michael Twyman, is an outstanding example of such a program.

Research Foundations for Information Design

Although there has always been a component of skilled practitioners thinking analytically about information design, research is becoming increasingly specializedóand fundamental. Compared to other professions, however, information design has barely begun to develop and integrate its own research community; it still draws on other fields for its research base. Fortunately, more and more researchers are becoming interested in the problems information designers must solve.

Information design rests, therefore, on a variety of research foundations, including such disciplines and subject areas as human factors in technology, educational psychology, computer interface design, performance technology, documentation design, typography research, advertising, communications, and structured writing. Some of the more important summaries of the research in these areas are

Interface design: Smith and Mosier (1986), Shneiderman (1987, 1992)

Educational materials design: Fleming and Levie (1993)

Typography: Evans (1974), U. S. National Bureau of Standards (1967),Tinker (1963)

Visual communication and learning: Goldsmith (1984), Pettersson (1989), Horton (1991)

Quantitative display of information: Cleveland (1985)

Research in cognition, which provides both a theoretical base and experimental data, is becoming fundamental to all of these fields (see, e.g., Eysenck and Keane 1990). In medicine, information design research and applications parallel to work carried out in many of the above-mentioned research domains goes under the name medical informatics.

Foundational Research: Structured Writing

Structured writing (called Information MappingÆ in its commercial applications) is foundational to some areas of information design. It provides a systematic way of analyzing any subject matter to be conveyed in a written document. Production of a written communication (such as a report, memo, proposal, training manual, procedural or operations manual, or electronic performance-support system) requires a method for ensuring that all relevant subject matter has been obtained and is presented in the form the user needs. Structured writing is such a method. It consists of a set of techniques for analyzing, organizing, sequencing, and displaying the various units of information. One of the insights gained from structured writing is that the paragraph is too poorly defined to be a basic unit of the analysis. Instead, structured writing divides information into domains in which basic unitsócalled information blocksócan be precisely described. Forty such information blocks can be used to sort 80 percent of the sentences found in writing about most relatively stable subject matters (such as the sentences found in training manuals and introductory textbooks). The ability to provide such precise functional descriptions has been used in the design of various training and reference documents. Although this is not the place for a full description of structured writing, we should point out that it is a mature methodology based on over twenty-five years of research and business implementation (Horn 1989, 1992a, 1992b, 1993, 1997). It has more than 200,000 users in the business and technical writing professions and has become part of the democratization of information design. So far, structured writing has been used primarily by writers. Information designers working in other fields are only now beginning to understand the importance of using structured writing as one of the secure foundations for analyzing the subject matter of documents.

Failure to Fully Integrate Research

It is symptomatic of a recently self-conscious profession that its knowledge of itself, its practices, and its research foundations are only partially known to practitioners. Many information designers have not read much of the research relevant to the profession. Perhaps one example will show what I mean. There is widespread interest among information designers in devising iconic signage for public places, even though research has cast doubts on the viability such an enterprise at this point in history. In one study of 108 international symbols (32 of which are widely used), fewer than half of the respondents clearly understood what 86 of them meant. Only three of the symbols were understood by more than two-thirds of the sample (Easterby and Graydon 1981, summarized in Sless 1986).

Other studies producing similar results induced me to advocate the use of what I call VLicons((Visual Language icons) rather than icons. VLicons integrate words and images in the same small communication unit (Horn 1998) and often perform some of the same important semantic functions as icons. They identify, they focus attention, they help set a mood, and they may aid in retrieval. But

they differ from icons in that they do not attempt the task of full communication with images alone. Instead, VLicons take advantage of the best aspects of words and images and integrate them tightly to convey meaning. They utilize the possibility that words and images effectively combined can disambiguate each other. Information design is still to some degree the prisoner of an old either-or paradigm in which words and images exist in completely separate domains of use.

Tensions in Information Design

As a profession, information design is currently experiencing a variety of tensions. Often these result from the clash of different ideologies or value positions that have grown up in the course of solving particular problems and have been extended to uses beyond their original boundaries (see Figure 2.2).

Value Differences

There is, for example, a considerable tension between (1) graphic designersówho learn in art school to worship the gods of Style and Fashion, Novelty, Impact and Self-expressionóand (2) technical communication peopleówho worship the gods of Clarity, Precision, Legibility, Comprehensibility, and (often) Simplicity. The graphic designers grew up in schools where Advertising and Fashion were the Senior Deities. The technical peopleís Senior Deity is Communication. Some graphic designers fall in love with a particular typeface and size and use it at the expense of clarity of communication. Many graphic designers assigned to help the training and documentation organizations of a company appear to be incapable of imagining that someone else might have a different set of values. When I was CEO of an information design consulting company, I often asked documentation and training managers to state their major problem. I expected to hear that it was tight budgets or short deadlines for producing documents (especially in the software industry). This is what they told me: ìGraphic designers are my biggest headache, because they simply wonít produce simple illustrations for our manuals. They wonít listen.î

The information design community is just beginning to create a self-identification. As a result, working relationships among the different professions out of which it is growing are often uneasy. Practitioners sometimes see themselves, first and foremost, as engineers, architects, graphic designers, or illustrators (or as psychologists, educators, or writers) and only second as information designers.. Nonetheless, when asked about their problems, they usually point to common issues. They also admire a common set of books (many of which are cited in this article). What they get excited about is information design, not the problems of their particular profession.

The tension between the graphic designers and researchers is also important. Researchers tend to avoid trying to measure style, novelty, and self-expression, partly because it is very difficult and partly because their research grants and contracts usually come from organizations whose major commercial priority is evaluating the clarity, legibility, and efficiency of communications. This tension sometimes also grows out of the vastly different social, economic, or moral values of designers and researchers working in advertising and information designers and researchers in more technical communication fields.

Democratization

Every profession has the problem of trying to exclude those who ìdonít know what we know.î The professional says, ìLet us do it. Weíre the professionals. We have secret knowledge. You donít really know how to do it right.î This possessiveness is to be expected. Information design has already begun trying to defend its boundaries. Unfortunately, some information designers perceive a threat in the democratization of information design that has resulted from putting information design features into computer software.

Already, there are business graphics and statistical packages advertising that the charts and graphs they produce follow principles researched and outlined by information design pioneers Edward Tufte and William Cleveland. This is occurring even though some people who call themselves information designers have not yet heard of Tufte and Cleveland!

Other software packages being designed today are gobbling up various areas of information design expertise. There is software that incorporates publishing and page-design principles commonly taught in art school. Some software packages provide templates that automatically incorporate principles of color combination, so that a user only needs to choose a cluster of colors that work together. When you can describe rules and guidelines with sufficient precision and stand behind

them with sufficient research, you can put them into software so that anybody who buys the software can use them.

The ubiquity of the computer prevents us from even asking whether further democratization of this nascent profession should be welcomed. We do not have a choice. The computer provides millions, if not tens of millions, of people with the capacity to do at least a modicum of information design in the everyday documents they prepare. Thus tensions between a profession trying to emerge and consolidate and the multitude of amateurs performing many of the same tasks are likely to continue.

Information Design and Visual Language

Information design can be thought of as the professionalization of another communication phenomenon: the emergence of a new language. Visual language is defined as the tight coupling of a words, images, and shapes into a unified communication unit (Horn 1998). ìTight couplingî means that you cannot remove the words or the images or the shapes from a piece of visual language without destroying or radically diminishing the meaning a reader can obtain from it. In diagrams, for example, you cannot remove the boxes or arrows without severely damaging or destroying the communication. Words and images are tightly integrated in most business slide presentations and in many examples of information graphics used by newspapers and magazines. Similarly, tight integration is apparent in the words and images in comic books, in most advertising, as well as in most video, film, and animation. A great many publications, both in paper and on-line, are now composed at least partly of visual language.

Visual language is a language, I maintain, because one cannot understand its syntax, semantics, or pragmatics by using only the linguistic concepts developed to analyze spoken languages. Nor are the tools of analysis used by either the visual arts or linguistics sufficient to analyze what is happening in visual language. To create a true linguistics of visual language we need new concepts that focus on how words and images work together.

Visual language has emerged just as other languages haveóby people creating it and speaking it. It has evolved, I believe, because of the urgent needs of contemporary individuals and organizations to deal with complexity. Many ideas are best expressed with visual language, and others can only be expressed by visual language.

Along with information design, visual language has also developed rapidly in the past decade because of the personal computer and, especially, the widespread availability of computer graphics programsósoftware that allows the user to draw, paint, and present quantitative information in chart form. In many ways, practitioners of information design have been the inventors and first users of visual language. They have helped it spread. And, as visual language has become democratized into what some now call our visual culture, many people have realized that there is a great need for more professionalized information design.

Changes in the Ratio of Visual Elements to Words

One major shift research has called attention to is the dramatic increase in the image-to-word ratio in documents of all kinds (Horn 1998). Many publications that in the past might have used one illustration per article now have one illustration per page. Thus the sheer volume of visual elements has changed. But that is not all. In my characterization of visual language, I focus attention on the tight integration of words and visual elements, whereas in the old document paradigm, words and images are separated. Images were referred to as figures and often did not even appear on the page on which they were discussed. That practice is changing; more and more, words and images are coming together.

Also underway is ìthe Great Sorting Out of the Functions of Words and Images When They Are Tightly Integrated.î In the Sorting Out, we study what words do best and what it is that the visual elements do best when the two are tightly integrated; that is, we are developing the functional semantics of visual language. It turns out that we need a whole set of new guidelines and rules for understanding this tight integration, principles that are quite different from those used when words and images operate separately (Horn 1998). As we understand this integration more and more comprehensively and deeply, we apparently increase the integration of our own words and images. This has happened in my own work on the analysis of the words and images in diagrams: they have become more integrated. The functional semantics of visual language can now be extended to fully effect the tight integration of visual elements and words.

Conclusion

In ancient times, scribes had to invent the papyrus on which they wrote. Over many centuries they modified writing symbols from ideographs to phonetic script to meet the changing needs of their times. Their modern counterparts, tomorrowís information designers, will also have to improve the tools and techniques of their trade to meet the even more rapid and complex changes of the twenty-first century.

The profession may well develop along the lines taken by medicine, where training in the foundational sciences is combined with internships, residencies, and practice to train the effective professional. In many ways we already see this kind of training emerging in the field of interactive interface design (Winograd 1996).

If the profession becomes more unified and practitioners understand that it rests on a multifaceted foundation of both creative design and rigorous research, it will continue to make major contributions to solving human communication problems. This future will require greater professional self-consciousness, the development and sharing of good practices, and increased incorporation of research findings into the design process. And, finally, it will require all of us to accept the democratization of information design.

R. Horn Home

Notes

1. Current research on the use of information can be found in many sources, including Special Interest Group on Graphics (SIGGRAPH) andSpecial Interest Group on Computer-Human Interaction (SIGCHI), All publications of the Association of Computing Machinery (ACM), research journals in human factors engineering and the graphics arts, and, especially, the Information Design Journal (address:Information Design Association, PO Box 239, Reading RG6 2AU, England; e-mail: ltstiff@reading.ac.uk) and Visible Language (U.S.A.), published by the Rhode Island School of Design (R.I.S.D., Graphic Design Dept., 2 College Street, Providence, R.I. 02903).

2. The primary source of training in structured writing is Information Mapping, Inc. (address: 300 Third Avenue, Waltham, Mass. 02154; telephone: 617-890-7003). Information Mapping is a registered trademark of Information Mapping, Inc.

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R. Horn Home

1998
Structured Writing as a Paradigm

by Robert E. Horn

A chapter from *Instructional Development: State of the Art* edited by Alexander Romiszowski and Charles Dills, Englewood Cliffs, N. J., Educational Technology Publications, 1998

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Introduction

Thomas Kuhn (1962) suggests that "normal science" consists of "research based upon one or more past scientific achievements that some particular community acknowledges for a time as supplying the foundation for its further practice." These achievements were (l) " sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity," and (2) "sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to solve." He then states that this is his definition of a paradigm: "Achievements that share these two characteristics I shall henceforth refer to as paradigms." Although Kuhn goes on in the same book to use the word "paradigm" in at least twenty-one distinct meanings (as cataloged by Masterman, 1970), this is the only place where he explicitly defines the term. Others have broadened the meaning of "paradigm" and still others have used the term as a metaphor for "any theory or method or approach, large or small."

If any writing or instructional design approach can be called a paradigm within Kuhn's definition, I will claim that structured writing most certainly qualifies. And if Kuhn's concept of paradigm can be metaphorically extended beyond the sciences to the realm of practical methodology of communication, then structured writing surely qualifies there as well. My approach in this chapter will be to describe what I believe to be the salient characteristics of structured writing and to describe the "past achievements" that supply "the foundation for further practice." Then I will demonstrate briefly how these achievements have been "sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity" and finally to describe some of the sorts of issues in the research and evaluation that structured writing focuses us on today.

1. What are Some of the Problems that Structured Writing Addresses?

Structured writing has been developed to address many of the perennial problems most people have when working on a complex written communication task. Instructional design certainly qualifies as such a complex task. Some of these perennial problems are:

- How should I organize the mass of subject-matter material?
- How can I keep track of the structure? How can the reader keep track?
- How can I make the structure of the document and the subject matter more obvious?
- How do I analyze the subject so that I am sure that I have covered all of the bases?
- How do I know the coverage is complete? How will the reader understand this scope?
- In large analytic and communication tasks, how do I track multiple inputs, different levels of reader competence and rapidly multiplying and increasingly demanding maintenance requirements?

- If I am working in an organization with a large number of writers, how do I provide the plan for a group of writers and how do I manage the group -- efficiently --so that it will appear to the reader that there is a unity or organization, structure, analysis, style, graphic display and format?
- How do I sequence the final document so that it will present the information to different levels of readers in the most useful manner?
- How do I organize the linkages so that different readers with different backgrounds can get what they want from it easily and quickly?
- What formats are optimum to enable users to make sense of the document as a whole and through the window of the current display?
- How do we make instructional writing optimally effective and efficient?
- These problems are not unique to instructional design. They are addressed one way or another by every person who writes a document. But they are the major issues faced by the paradigm of structured writing. The remainder of this chapter will examine how structured writing helps writers tackle these questions.

2. What are Some of the Presuppositions of Structured Writing?
In this section I will present several of the major presuppositions of structured writing to provide the background that I used to formulate the paradigm of structured writing.

I have used these presuppositions without entering current cognitive science debates as to whether or not we really use some kinds of representations within our minds and brains. Rather, I simply observe that when we communicate, we do use representations.

Presuppositions about Subject Matter. I began with what seemed obvious, namely that, since we communicate with each other using physical mediums we have to represent what we do in sentences and images. Thus, any subject matter consists of all the sentences and images used by human beings to communicate about that subject matter. So, with sentences and images, we have all we need to fully analyze a subject matter. I acknowledge that subject matters exist that can only be learned by intense observation, practice and nonverbal feedback (such as an exotic martial arts). I acknowledge the issues raised by Polanyi in his concept of tacit knowledge, i.e. that certain knowledge is learned by observation of fine motor movements and unvoiced values, which go beyond the sentences that represent a subject matter. But I sidestep them. Structured writing only deals with that which can be written. Practical communication in commerce, science, and technology teaches, documents or communicates something. Therefore, I assume that what is important enough to learn is capable of being rendered in sentences (or diagrams).

I also assumed that the most important regularities to understand in a subject matter are those that exist between sentences. Many of the studies of language begin and end with the study of words and sentences in isolation. Subject matters are tight relationships between many clusters of sentences and images. So, if we are to analyze subject matters properly (i.e. efficiently and effectively) for communication and training, we must understand the relationships between sentences. Why is it that certain sentences should be

"close" to each other in an instructional document in order to convey the subject matter easily to a new learner?

Presuppositions about readers. There were a number of assumptions about the users (or readers). I took it as axiomatic that different readers and learners may want to use a given document in a variety of ways. Readers may use any of the following approaches to a given document: scanning to decide whether to read the communication at all, browsing to find interesting or relevant material, analyzing critically the contents, studying to be able to remember the subject matter, etc. And, in general, it is difficult to predict what learners and readers will do with a given piece of instruction or communication. Documents often have hundreds or even thousands of users. Each document has a different interest and relevance to each user. Each must therefore serve many people having many purposes. If possible, it is important to optimize among several functions in the same document.

Presuppositions about Writing. When I developed structured writing, I also introduced what turned out to be a fairly radical assumption: *A new paradigm in communication and learning* requires a new basic unit of communication. Revolutions in paradigms in physical theory have in part come about from the different concepts of the most basic particle (the atom as a singular unit, Bohr model of atom as a subvisible solar system, electrons as rings of probability, to the discovery of subatomic particles, etc.). Revolutions in linguistic theory came about with the invention of grammar as a unit of analysis. The behavioral paradigm in instructional design came after Skinner's invention of the stimulus - response unit. Similarly, the invention of the information block (discussed below) qualifies as a major turning point in the history of the conception of basic units.

Most training is not formal training. It does not take place in the classroom with documents called training manuals. It takes place on the job with whatever documentation is at hand. I have heard that only one-tenth of training is formal classroom training. Nine-tenths never gets accounted for in the financial or other reports of a company as training. Thus, in my list of major assumptions is this one: Anything that is written is potentially instructional. Therefore, in so far as possible: A writer should design each communication to potentially be "instructional" even if its ostensible job may be as a memo or a report or as documentation.

Another focus on the structured writing presuppositions began is giving importance to the scientific research on how much people forget. We forget, as I am sure you remember, most of what we learn within three weeks of learning it. At that time, I noted that we must build "learning - reference systems" in order to deal with these problems. (Horn, et. al., 1969) . Since then we have used the term "reference based training" (Horn, 1989a) to cover this area. Others have invented the delightful term "just in time training" to cover an essential aspect of this training need. And later I specified the domains of memos and reports as another arena in which writing with instructional properties takes place. (Horn, 1977)

With this survey of the assumptions underlying the paradigm, let us take a look at the actual components of the structured writing approach.

3. What Are the Components of the Structured Writing Paradigm?

My early (Horn, 1965) analyses began with the detailed examination of actual sentences, illustrations, and diagrams that appeared in textbooks and training manuals. My investigation involved trying to establish a relatively small set of chunks of information that are (1) similar in that they cluster sentences (and diagrams) that have strong relationships with each other and (2) that frequently occur in various kinds of subject matter. This analysis focused, thus, on the relationship between the sentences in subject matter. The result of this analysis was the invention of the information block as a substitute for the paragraph. The taxonomy that resulted is now known as the information blocks taxonomy for relatively stable subject matter (shown in Figure 1).

Figure 1
Most Frequently Used Block Types
(in domain of relatively stable subject matter)

Analogy	Description	Notation	Specified Action Table
Block Diagram	Diagram	Objectives	Stage Table
Checklist	Example	Outlines	Synonym
Classification List	Expanded Procedure Table	Parts-Function Table	Theorem
Classification Table	Fact	Parts Table	When to Use
Classification Tree	Flow Chart	Prerequisites to Course	WHIF Chart
Comment	Flow Diagram	Principle	Who Does What
Cycle Chart	Formula	Procedure Table	Worksheet
Decision Table	Input-Procedure-Output	Purpose	
Definition	Non-example	Rule	

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Definition: Information Blocks

Information blocks are the basic units of subject matter in structured writing analysis. They replace the paragraph as the fundamental unit of analysis and the form of presentation of that analysis. They are composed of one or more sentences and/or diagrams about a limited topic. They usually have no more than nine sentences. They are always identified clearly by a label. Three examples of information blocks are shown in Figure 2. Information blocks are normally part of a larger structure of organization called an information map (see below for explanation of maps). In short, they are a reader-focused unit of basic or core parts of a subject matter.

Example of an Information Block

What do information blocks look like? It is important to notice that different types of blocks vary widely in appearance and construction. For example, below is one of the most simple-looking types of blocks (but one that has standards for construction more stringent than most), a definition block:

Definition. The Master Payroll File is a group of records containing all of the payroll and employee information used by the weekly payroll program.

How is a Block Different from a Paragraph?

Let us examine some of the characteristics of this example of an information block and see how it differs from paragraphs. First, we must note that there is no topic sentence in the information block. Topic sentences are absent or irrelevant in much of structured writing, so much so that they are not taught in a structured writing course.

Second, it is worth observing that there is no "nice to know" but irrelevant information in the information block. Note that the only information it contains is information that is relevant to defining the term Master Payroll File. Paragraphs typically have a lot of nice to know information.

Third, note that the block has a label. One of the mandatory requirements for blocks is that they always have a distinguishing label, chosen according to systematic criteria (Horn, 1989a). Paragraphs have no such requirement, although they may be randomly labeled, depending upon the taste of the writer.

Fourth, All definitions in a given structured document would be consistent with these characteristics. Paragraphs have no requirement for consistency within or between documents. These are some of the main characteristics that distinguish the block from a paragraph.

This first example is a very simple block. While this block is one sentence long, many types of blocks contain several sentences. diagrams, tables or illustrations, depending upon their information type. (See Figure 2) Typical blocks are several sentences in length, and might contain different kinds of tables: Diagrams comprise other kinds of information blocks.

Figure 2
Some Different Kinds of Information Blocks

Information Block Containing a Table

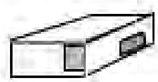
Decision

IF the book is	THEN send the patron	AND send . . .
available	the book	an invoice to the Billing Unit
not available - never owned - lost	Form 25	—
checked out with no waiting list	Form 66	a copy of Form 66 to Circulation Desk.
checked out with a waiting list	Form 66 and Waiting List Notice	a copy of Form 66 to Circulation Desk.

Information Block Containing One Sentence and One Diagram

Diagram

The terminal is held in place in the connector cavity by a locking tang. The attached cable allows you to move and position the terminal.



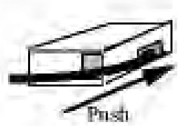
Information Block with Several Sentences and Several Diagrams

Procedure

Step 1

Push the cable forward until it will no longer slide.

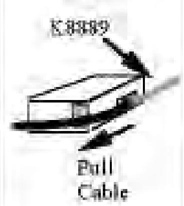
Example :



Step 2

Insert the K8889 tool through the hole on the opposite side and gently pull the cable out.

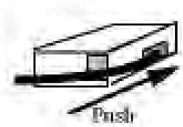
Example :



Step 3

Inspect the terminal. Replace if necessary and then replace the cable by inserting is into the locking tang.

Example :



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How Does Structured Writing Handle Cohesion and Transition?
There is no "transitional" information in the information block, but principles for writing prose encourage or require it. The need for coherence, cohesion, and transition is handled in a completely different manner in structured writing. While this is a huge topic, (Halliday and Hasan, 1976) suffice it to say that much of the burden of coherence is placed on the labeling structure and much of the transition requirement is placed on one type of block, the introduction block, that frequently appears at the beginning of information maps.

The Four Principles
All information blocks are constrained by four principles used to guide structured writing:

The first of these is the **chunking principle.** It derives from George Miller's basic research (Miller, 1957. See also note 2) which suggest that we can hold only 7 plus or minus 2 chunks of information in human short-term memory. Our formulation of the principle states: Group all information into small, manageable units, called information blocks and information maps. Small (in information blocks) is defined as usually not more than 7 plus or minus 2 sentences. While others lately (e.g. Walker, 1988) have recommended modularity (i.e. dividing information into labeled chunks) as a principle of structured writing, I have insisted that information blocks turn out to be "precision modularity" (Horn 1989a, 1993) because of the operation of three other principles with the chunking principle and because I believe we have shown that blocks sorted using our taxonomy (see below) offer much greater efficiency and effectiveness of composition and retrieval.

The second principle we use in helping to define the information block is the **labeling principle.** It says: Label every chunk and group of chunks according to specific criteria. It is beyond the scope of this paper to get into all of these criteria. They consist of guidelines and standards some of which cover all blocks, some of which cover only specific types of blocks or even parts of blocks. I have claimed elsewhere (Horn, 1992a) that it is the precise specification of different kinds of blocks that permits the identification of context and limits for these criteria, thus saving them from being bland and overly abstract, and, thus, largely useless, guidelines.

The third principle used in developing the information block is the **relevance principle.** It says: Include in one chunk only the information that relates to one main point, based upon that information's purpose or function for the reader. In effect it says, if you have information that is nice to know, or contains examples or commentary, the relevance principle demands that you put it some place else and label it appropriately: but do not put it in the definition block.

The fourth principle is the **consistency principle.** It says: For similar subject matters, use similar words, labels, formats, organizations, and sequences.

Answering Some Objections to Blocks

Some have commented that information blocks are not particularly unique or novel. They say, for example, that information blocks are only what paragraphs, when written properly, should be. I have answered many of these claims elsewhere (Horn, 1992a). If extraneous information is excluded from an information block (as it should be, following the relevance principle) the discourse is changed radically. If the materials for cohesiveness and transition in paragraph-oriented writing are put into the labels and if the labeling system is relevant and consistent, the appearance and usefulness of the whole piece of writing is changed tremendously. If the subject matter is divided into appropriate-size of chunks (using the chunking principle and the taxonomy of information blocks), the form of discourse is changed decisively. If all of these changes are made together in the same document, the text usually has much less intertwined prose with multiple threads and allusions. It is a far more usable text to scan, to read and to memorize.

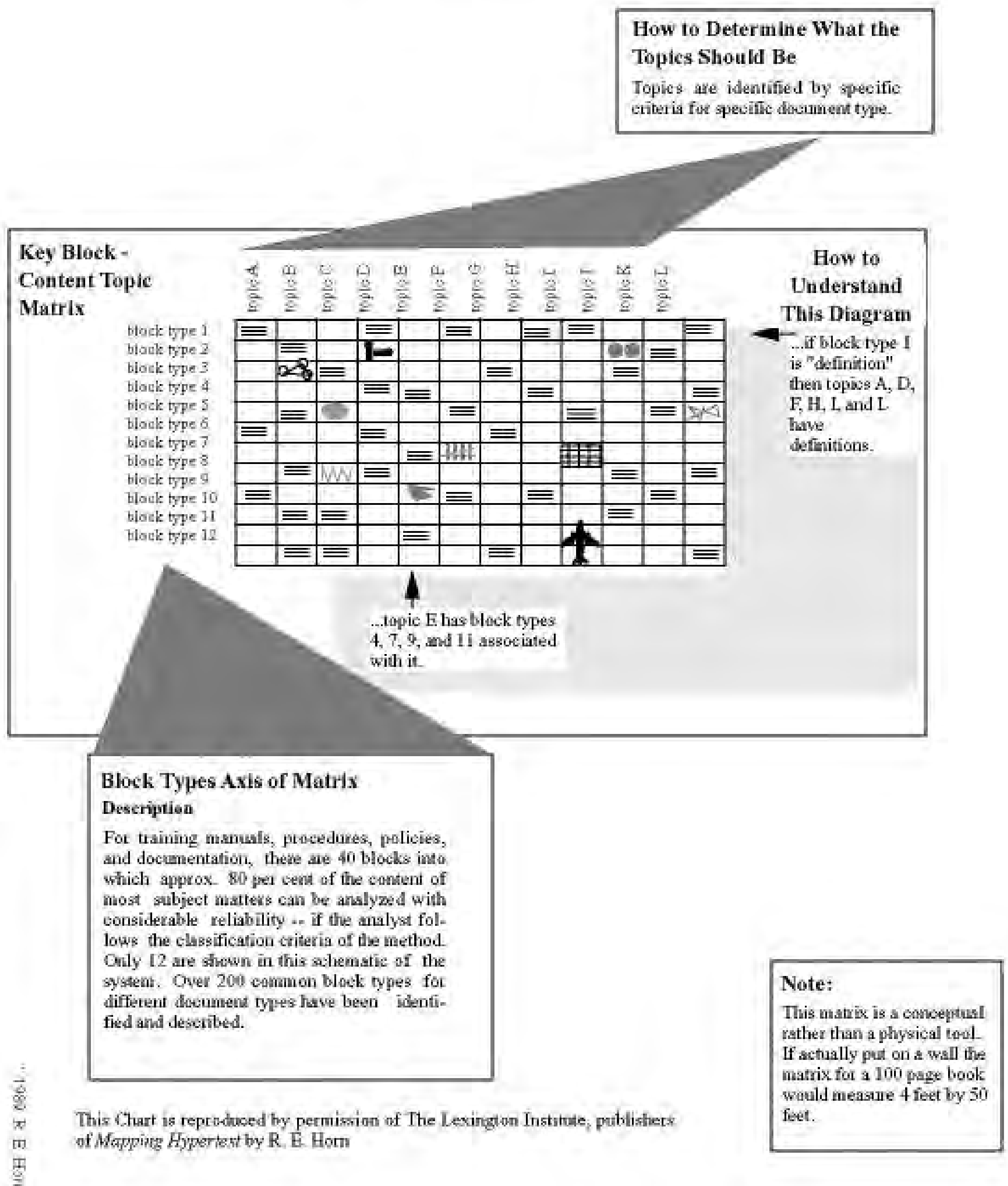
Blocks by Themselves Qualify Structured Writing as a Paradigm.

By itself, the invention of the information block might qualify structured writing as a separate and new paradigm for analysis and writing. But we used these new distinctions to build a powerful analytic tool for gathering information about and specifying the subject matter in instructional or documentation writing. Simply revising the basic unit has radically shifted the rhetoric of exposition in the documents in which structured writing is used.

Topic - Block Matrix of a Subject Matter

To aid analysis of subject matter for instructional and documentation purposes, I conceptualized the subject matter as a topic - block matrix, shown schematically in Figure 3.

Figure 3
Block Type - Content Topic Matrix



The reader will note that the topics from the subject matter are arranged along the top of the matrix. This is done according to a group of guidelines provided as a part of the structured writing system. The block types (see Figure 1 for list) are arranged along the vertical axis. The resulting cells in the matrix represent information blocks into which the

sentences and diagrams from the subject matter are placed. Examination of the blank spaces show the analyst what information may still be not written down and hence perhaps not known. Specific templates have been developed which permit the analysts to know with a high degree of certainty which block should be filled in for a specific topic. An example of this would be a template which would specify these three block types for a concept: definition, example, and (optionally) non-example.

Systematic Labeling

Another key component of structured writing was the development of a system of consistent labeling of parts of a document. Obviously labeling is not unique to structured writing. Many books follow a more or less systematic labeling guideline. But when combined with the new units of communication, the information block and the information map, the systematic labeling becomes a powerful communication device. In a recent article (Horn, 1993) I summarized the benefits of such a systematic approach to labeling. Systematic labeling:

- enables readers to scan content to see what they want to read
- enables readers/learners to to find what they are looking for in a consistent, relevant, complete manner;
- enables the analyst/writer to manage the intermediate stages of information gathering and analysis in a more efficient way;
- enables learners to anticipate learning problems by showing the structure of the subject matter to them."
-

Definition: Information Maps

Information Maps are a collection of more than one but usually not more than nine information blocks about a limited topic. In general, one can think of an information map as approximately one to two pages in length, but some maps (of certain well-specified types) run several pages in length and some maps are composed of only one information block. Maps both (1) aid the writer in organizing large amounts of information during the analysis phase and (2) help the reader to understand the structure of the subject matter and the document. Maps may be sequenced hierarchically or in other clearly defined ways such as task or prerequisite order. Maps are assembled during the sequencing phase of the writing process, into parts, sections, chapters and documents depending upon communication purpose and reader needs. (For an example, see Figure 4.)

Figure 4

Example of an Information Map

Comparing 17.1.0	**Regular Data Values, and . . .**	**Non-Regular Data Values**
Introduction	Some data have patterns. They progress by fixed increments.	Some data do not show any pattern of intervals between the values.
Definition	Data are called regular when the values of a data vector progress from some initial value with some fixed interval to another value, and then optionally from that to still other values by even increments.	Data are called "non-regular" data when they have no systematic pattern of intervals between them.
Example One	Time data show frequent regularities. Samples of blood collected from a laboratory animal every hour on the hour might be called SAMPLEHRS and might look this way: SAMPLEHRS = 6, 7, 8, 9, 10	Most measurement data do not exhibit systematic regularities that are fixed intervals between values, so they are usually non-regular data. Here is an example: LABMEAS - .01, .09, .04, .3
Use This Input Statement	Input with Computed Clause Statement	Standard Input Statement
Comment	This statement permits you to input regular data in a very compact form and is much quicker to type than a normal input statement.	This statement should be used for normal data entry.

Related Pages

Input with Computed Input Statements, 22
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Discourse Domains
Communication in business takes place in some fairly routinized forms. This fact enables us to identify some major domains of discourse. We begin such an analysis by asking questions about specific domains such as: How does a report of a scientific experiment differ from a sales presentation or a policy manual? They differ in many ways. They differ as to who the authors are, how the authors have come to know the subject matter, what can be assumed about the audience of the communication, what level of detail is used, what content is communicated.

In addition to the "what are the differences" questions, we can ask the "what are the similarities" questions. How are all reports of scientific experiments alike? How are all sales presentations alike? The analysis of these similarities and differences is what is called domain analysis in structured writing. It involves examining the relationships between author and reader of different kinds of documents and the "stances" and points of view that can be seen as a result. This analysis yields specific block types that can be expected in specific kinds of documents. The domain of relatively stable subject matter has already been introduced in this chapter as the one that comprises the subject matter used in training and documentation writing (see also below).

So, in the Information Mapping method, a domain of discourse is defined as the specification of information blocks of a particular class of documents, all of which share the same type of author-reader assumptions and the same stance or point of view towards subject matter.

Some examples of domains of discourse (Horn, 1989a) have been studied extensively. They are:
- the domain of relatively stable subject matter, which is that domain of subject matter which we think we know well enough to teach it in a course or write an introductory training material about it.
- the domain of disputed discourse, which is that subject matter about which we know enough to chart its disagreements.
-

Other domains such as those of business report and memo writing have been studied (Horn, 1977) Still others remain to be carefully identified and mapped.

Information Types
Blocks in the domain of relatively stable subject matter can be sorted into seven basic classifications, which we call the "information types."
The seven information types are:
- Procedure
- Process
- Concept
- Structure
- Classification
- Principle
- Fact

This is a key set of categories for specifying and describing how human beings think, especially about what we have called relatively stable discourse domains. Structured writing guidelines have been developed that permit the information blocks to be assigned to one or more of these information types. An example would be the assignment of definitions and examples to the information type "concept" or the assignment of a flowchart to the information type "procedure." This permits the identification of what has come to be called "key block" information, the information which you must have to fully analyze an individual topic of a subject matter. Key blocks enable writers to anchor their writing firmly and reliably to the centrally important structure of a subject matter. (For further information, see Horn, 1989a, Chapt. 3)

The information types theory is used to help the analyst/writer identify specific information that is needed for each topic. These information-type templates specify the key information blocks needed to ensure completeness and accuracy of the analysis.

Systematic Integration of Graphics
From its conception, the structured writing paradigm recognized the importance of graphics (illustrations, diagrams, photographs) as an integral part of any writing with a practical purpose. This meant that we had to specify exactly where such graphics would communicate better than words by themselves. And this led to the identification of specific blocks within the overall scheme which are required to have some kind of graphic, because the communication was likely to be better than if the same message were conveyed only by words. This is also paradigmatic change. Certainly in the past words and images had been used together. But graphics were regarded either as a "tacked on" afterthought or as decorations, not as a mandatory and integral part of the message. (see Horn, 1993 for a fuller treatment of this point).

Systematic Formatting
Much reading in the Age of Information Overload is actually scanning. We must continually identify that which we don't have to read. We are always looking for the salient parts. This makes the requirement for aiding scanning paramount in the specification of formatting. There have been a variety of formats identified that meet this criteria. Structured writing is most often associated with a single format: that of having the map title at the top and the block labels on the left-hand side of the page. But this is only one of the many possible formats of structured writing that aid scanning (see Horn, 1989 for others). The topic of formatting is also the one that has produced the most confusion about structured writing. Many people have observed only the strongly formatted versions of documents written according to the analytic methods of structured writing and have concluded that "it is only a format." Since the analysis and structuring of the document is part of the process of producing the document, much of the highly disciplined thinking that goes into producing the documents is not immediately visible. But the number of trained writers of structured writing has grown to over 150,000 world-wide, and the discernment that something more than format goes into structured writing has gradually become the norm rather than the exception.

Systematic Life Cycle Approach to Document Development
Documentation and training materials often last a long time. The amount of time from drafting to final discard of a document can be years and sometimes decades. Many business documents are frequently revised and updated. This means that a methodology for writing must have in place a facility for rapid revision and updating as well as cost-effective initial development. The structured writing paradigm has made paradigmatic changes in how documents can be updated and revised. Because the basic units of organization, the information blocks, are easily isolatable from each other (unlike other paradigms of writing and formatting), they can be much more easily removed, changed or replaced. Previous and more literary rhetorics provide a great deal of difficulty to the writer managing the life cycle of the document, because such literary rhetorics have an intricate and highly interwoven approach to organization. Managers involved in preparing foreign language translations also report major efficiencies of translation because of the simplification of rhetorical structure. Needless to say that the structured writing approach propagates rapidly in a business environment in which costs of publication are closely watched.

What Structured Writing Shares with Other Paradigms
Not all of the components of structured writing are novel. Such total novelty is not a requirement for a paradigm. Structured writing shares the use of words and sentences with other forms of writing. Many of the conventions and rhetorical guidelines for good, clear writing of sentences are incorporated without change. Moreover, when serving a purely instructional function, most of the guidelines regarding the design of practice exercises, tests, criteria-based instruction, etc. are used wholesale.

Behavioral research from instructional design, such as Merrill's and Tennyson's (1977) work on teaching concepts, has also been incorporated into the structured writing paradigm. This research serves to strengthen the instructional properties of documents whose initial or primary use is not instructional, but which at some time in the life cycle of the document must provide formal or informal training. Moreover, as another example, much of the collection of research-based design imperatives in Fleming's and Levie's (1978) work on message design supported and strengthened the research foundations of the structured writing paradigm, as have many individual pieces of research since then.

4. What Makes Structured Writing "Structured?"
One of the claims of structured writing is that there exist particular dimensions along which technical or functional writing can be described (if observing it from the point of view of an outside observer) or composed (if attempting to develop some document using it). It seems to me that we can describe several scales of structure or dimensions along which a piece of prose would be placed. Some of these scales are:

The Chunking Scale. This scale might be described by the question "to what degree can the between-sentence units be clearly chunked into separate chunks, each of which serves only one purpose?"

Most ordinary prose paragraphs would be placed on the low end of this scale simply because they mix functions. For example, many paragraphs mix introductory and definitional functions, while highly structured writing keeps them separate. I have itemized and described forty such functions for chunks (which I call information blocks) appearing in the domain of relatively stable subject matter (the domain of text books, procedure and policy manuals, etc.). Dividing subject matter strictly according to this taxonomy of chunks produces highly structured chunking.

Making the structure visible with labels. Does such a highly chunked writing style produce highly structured writing? To some degree it does. But there are other dimensions to consider. One of these has to do with whether or not the reader can actually see the structure by glancing at the page. Three factors contribute significantly to making the structure visible.

One factor is whether or not the chunks are labeled. If the chunks are clearly and functionally labeled the reader will be able to scan the labels and get a gist of the document as a whole. The second factor is actually a group of design elements that include format (where the labels are placed) and type style (such as size and boldness of the labels). A third factor is whether there is a systematic application of labeling -- the application of the consistency principle.

So we have three more possible scales or dimensions of "structuredness" to consider. Clearly most prose falls down badly on these scales, while methods that have a labeling system will be rated as more "structured." And to determine "structuredness" we must use a multi-dimensional approach.

The Between-Chunk Sequencing Structure All of the dimensions of structure discussed so far could be done and we might rate the writing as poorly structured, because the way in which the chunks are put together does not present a clear structure to the reader.

There are many ways to arrange the sequence of chunks in a piece of writing. For example, arranging them hierarchically is one frequently used way . here again there are at least two distinguishable factors: (1) is the document organized according to some larger organizing scheme, such as the concept of nine different kinds of hypertrails as a basis for the structuring of sequencing (Horn, 1989a) and (2) can the reader see this at a glance? So again we have both the "inner organization" principle and the formatting principle at work.

These and other "dimensions" and their attendant scales might be devised to make a precise determination of structuredness in individual pieces of writing. (See Note 4)

5. Is Structured Writing "Sufficiently Unprecedented" and Has It Attracted an "Enduring Group of Adherents?"

Kuhn suggests that the paradigm must show achievements that were (l) " sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity."

Structured writing also qualifies as a paradigm in that it was presented all at once as a complete methodology, rather than incremental additions. This is not to say that no improvements or additions have been made. The major structures and components of structured writing have endured over 25 years (Horn, 1993) To review, the components that appeared together all at once are:
-The invention and description of the information block as a new kind of basic unit of communication that permits the use of truly structured writing;
-The precise specification of different kinds of information blocks for specific purposes, and in particular the specification of approximately 40 information blocks that comprehend over 80 percent of the domain of relatively stable subject matter and the specification of other clusters of block types for memos, reports, proposals and other document types;
-The invention of a content analysis approach of question and information types that clusters different information blocks to guide question asking and ensure completeness in the initial analysis of the subject matter;
-The invention and description of an intermediate unit of structured writing, the information map, that permits easy and natural topic clustering;
-The development of a comprehensive and systematic set of criteria for labeling blocks and maps;
-The systematic specification of where graphics should be used and where text would be better;
-The development of easy-to-scan formats that exactly fit with the analysis methodology and categories to aid learning and reference.

We have already described how these different characteristics and components represented dramatic departures from the customary practice at the time structured writing was introduced. Even today the conventional literary approach is still taught in most writing and instructional design courses, although many technical writing courses are adopting some kind of structured approach.

In recent years, the group of adherents to the structured writing paradigm has been growing by approximately 20,000 persons annually (Note 3). The total number of users stands somewhere around 150,000 as this chapter is written. These are primarily people in industry: instructional designers, people who write documentation and reports, managers who write memos and proposals, developers who build online and hypertext applications. Many of these people are taught in the largest companies in the world by a licensing arrangement (Note 3) which qualifies instructors to teach within a company that has made a commitment to training all of the relevant staff in the methodology. A considerable group of researchers has focused attention on the structured writing methodology as well (see next section). Altogether one can confidently note that structured writing has attracted an "enduring group of adherents."

6. Is Structured Writing Sufficiently "Open-Ended" for Research and Practical Application?

Kuhn's definition of paradigm requires that the theory be " sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to solve." Structured writing qualifies by this criteria in that it has produced a robust, ongoing stream of research and evaluation both in universities and in industry.

One test of this requirement is to ask if there have been major problems solved within the methodology after the initial paradigm was presented. There have been several. In 1977, a major extension of the methodology was made to the crafting of memos and reports. (Horn, 1977) Here the concept of the information block was kept intact, but a new domain was surveyed which resulted in the identification of fifteen basic types of reports and memoranda in industry and the identification of blocks that acted analogously to the key blocks in the domain of relatively stable structured subject matter. The formatting was modified and extended to incorporate requirements of the report and memo contexts. The idea of the map was modified in several ways while keeping its major purpose and the systematic criteria for the labeling of blocks was extended slightly.

A similar major extension was made in 1988 (Bellerive and Horn, 1988) by extending the approach to the preparation of proposals. Most of the major extensions used for reports were reexamined and found appropriate for proposals. A few modifications were made in the basic methodology to adapt it to the proposal context in industry. Similarly in 1989, the approach was applied to writing for computer user documentation (Horn, 1989b).

The structured writing approach has been shown to be analogous to other types of structured methodologies and can incorporate them into its larger dominion. One such area is argumentation analysis (Horn, 1989a, Chapter 7) which enables analysts to examine the form of argumentation presented by an author or speaker at various levels of detail in a diagrammatic way.

Another dimension of open-endedness should also be noted. From the beginning, I made no effort to complete the methodology. I have always said that the taxonomy of 40 information blocks for relatively stable discourse covers eighty percent of the subject matter. Why only try to achieve eighty percent? Why not attempt to identify ninety-nine percent of the information block types? First, eighty percent coves a lot of territory. Since key blocks which identify the core information in a subject matter, fall among this eighty percent, the most fundamental information is guaranteed to be there. Secondly, it would not be cost effective to try to specify all of the rest of the blocks. They tend to be idiosyncratic to particular subject matters and instructional contexts. Rather, I decided to go up a level of abstraction at that point and develop criteria for making new information blocks. What the writer does about the other 20 percent is to devise new block types. I used this open-endedness in my proposals to improve the writing of scientific reports and abstracts (Horn, 1989a, Chapter 8). Others have taken this approach in literally thousands of situations in writing industrial applications. This approach provides a continuous open endedness to the methodology. I might also mention that, in a similar area, writers are encouraged to combine different kinds of maps to suit the document they are creating.

A recent survey (Horn, 1992b) notes fifteen doctoral dissertations that focused on structured writing. One reviewer (Clark, 1993) was "surprised to see that most of the research done on the method has evaluated its effectiveness on learning outcomes, not retrieval speed or accuracy." (That was not surprising to me since the structured writing paradigm grew out of the instructional design context, not the conventional writing context.) Clark continued "Of the ten studies summarized (in detail in Horn 1992b), seven focused on learning and only two on retrieval time. In the learning studies, most compared the effectiveness of (structured writing) with 'conventional' materials on test scores. In two of the studies time was controlled; in the others learners studied as long as they wished." Figure 5 shows the results of the studies summarized in Horn 1992b. Clark concluded "It seems that there is fertile research soil to till with future studies that focus on speed and accuracy of retrieval from large reference documents prepared using various layouts. More cognitively-oriented research that includes protocol analysis while learners read would help to document not only effectiveness but get insight into the reasons for the effectiveness. Certainly reduction of cognitive loading would be one reasonable hypothesis to explore in comparing structured to conventional reference materials."

Figure 5

Results of Major Research Studies on Structured Writing

		Measured by Number Right or Errors	Time to Do Task	Supervisor Appraisal
Initial Learning	**Immediate Recall**	Stelnicki: 32% higher scores on facts; 41% higher on concepts Soyster: 13% higher scores Romiszowski: 10% higher scores Burrell: 53 - 59% better on tests Webber: 38% higher scores on the criterion tests	Romiszowski: 10% faster Webber: IM version was 50% faster	
	Long Term Recall	Soyster: No difference (attributed to motivation factors by the researcher)* Webber: IM version provided 85% or better accuracy when **starting** on the job.		
Retrieval	**Had Previously Used the Materials**	Jonassen & Falk: 33% higher scores with IM	Baker: IM had 12-21% better reading speed	
	Had Never Seen the Materials Before	Schaffer: 54.5% fewer errors with IM		
On-the-Job Application			Holding: Supervisors reported 32% de- crease in reading time for persons receiving reports written in IM. 84% of IM users report increase in writing speed after taking course.	Holding: Supervisors reported 100% of those who received training had producti- vity increase. Course was rated: ¥ very effective 63% ¥ effective 30% ¥ somewhat effective 7%

Key:
IM = Information Mapping's method
Names are names of principal investigators on specific research studies.

This Figure is reproduced with permission from the Lexington Institute, publishers of *How High Can It Fly? -- Examining the Evidence on Information Mapping's Method of High-Performance Communication* by Robert E. Horn

Many companies have now trained thousands of people in the structured writing methodology. More studies are needed to examine the impact of implementing the method throughout an entire organization. One such study (Holding, 1985) studied the impact of training 180 managers in structured writing seminars at Pacific Telephone. She looked at both the results on the writers and the readers (by interviewing their supervisors). On the writer side, there were decreases in writing time and increases in clarity, as well as improvement in analytical and organizing skills; which is not surprising given the extreme focus on analysis and organization in structured writing courses. All of

the supervisors surveyed stated that the amount of time it takes to read a document, using the method taught in the structured writing course, decreased. The mean decrease in the amount of time was 32 percent. Other advantages the supervisors reported included faster approval (of reports and memos) due to the methods used in the course (83%) . The supervisors and writers agreed that writers wrote their required letters and memos before deadlines. Further research along these lines would prove useful to other implementers.

The structured writing field has generally had to rely on research from cognitive psychology, educational research, and other fields for the close examination of its components and writing guidelines. There is a rich vein of potential research in this area as well. I have noted elsewhere (Horn, 1992a) that, while research in naturalistic settings such as jobs, classrooms and laboratories are important those settings may be the "wrong place to attempt to measure certain effects." I urged the field to devote more research time in the next phase of research to isolating variables . It would, for example, be helpful to know how much of the dimensions of "structure" contribute to the overall effects.

There is virtually unanimous agreement that much of what we read will be stored on computers in the next ten years. That conversion to online access and reading is proceeding steadily and is expected to accelerate. The availability of hypertext functions provides many opportunities for just-in-time instruction, but also provides managers with a panoply of problems (see Horn, 1989a, Chapter 2 for a survey of these problems). I have claimed that structured writing will help solve a good many for these problems (Horn, 1989a, Chapter 5).

It would seem that structured writing easily meets Kuhn's criterion of being "sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to solve" while at the same time providing practical solutions to today's busy instructional design practitioners.

#Notes

1. The primary source of training in structured writing is Information Mapping Inc. (Address: Information Mapping, Inc., 300 Third Avenue, Waltham, MA 02154; phone: (617-890-7003)

2. Originally I took Miller's dictum of 7 plus or minus 2 quite literally. Subsequent research on chunking has indicated that the ideas must be retained but in using them as a basis for structured writing guidelines, to consider them on a more metaphorical basis.

3. The estimate includes only those taught structured writing by Information Mapping, Inc. the major company teaching the methodology through its seminar division and its international licensees in the U. S., Japan, Australia, New Zealand, Mexico, and Europe.

4 In Information Mapping's method of structured writing, I generally set the standard toward the most highly structured end of the various dimensions and scales I have suggested in this article.

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2002
Argumentation Mapping

A chapter "Infrastructure for Navigating Interdisciplinary Debates: Critical; Decisions for Representing Argumentation" from Kirschner, Paul A. and Buckingham Shum, Simon J.,Eds. *Visualizing Argumentation: Software Tools for Collaborative and Educational Sense-Making,* Springer, 2002

Infrastructure for Navigation of Interdisciplinary Debates
Critical Decisions for Representing Argumentation

A draft chapter prepared for the forthcoming book
Visualizing Argumentation
Tools for Collaborative and Educational Sense-Making

by
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Visiting Scholar, Stanford University &
Distinguished Consulting Faculty, Saybrook Graduate School

Differences among types of debates.
There are differences between those argumentation mapping schemes that focus on supporting real-time disputes and those which support carefully crafted, heavily edited representations of the intellectual history of some of humanity's most significant and enduring debates. Table 1. suggests some of the important distinctions:

Debate Types	Audience	Purposes
Real-time Debates	Those currently involved in the debate	• capture debates and evaluations on the fly • document a project's decisions • support the development of the debate • serve as a tool for teaching critical thinking
Historical Debates	Educators, researchers, students	• display the intellectual history of the debate as well as the current status • provide a navigational framework for whole academic subfield • serve as a tool for teaching critical thinking

TABLE 1. A comparison between real-time and historical debates

Other chapters in this book describe approaches to the requirements for real-time debates. All of these approaches to argumentation analysis (historical and real-time) attempt to help people manage complexity and sort out differences of opinion and point of view.

Critical decisions must be made before software is designed.
This chapter will focus on the detailed sets of analytic and design decisions that need to be made to create effective argumentation maps on great debates, especially for use in teaching and learning. These are critical because once structure and graphic commitments

are made, software is costly and difficult to change. I will organize our approach by showing how we solved a series of analysis and design problems that are relevant to any computer-assisted collaborative argumentation work.

Problem: What level of detail?

Stephen Toulmin's pioneering book *The Uses of Argument* (Toulmin, 1957) was our inspiration. (1) (for a discussion see Shum chapter in this book) My initial impression was that he had solved all the problems. So I immediately attempted to use his diagrammatic approach (Toulmin et. al., 1979) with such public policy questions as the use of nuclear weapons (Horn, 1989, 200-203). But there was a major problem with the Toulmin approach: using it for a large, complicated argument created a huge tangle. It was fine for 5 to 10 sentences, but it became spaghetti for more. After experimentation we found that we were interested in portraying argumentation analysis at an overview level. Thus, argumentation mapping had at least two levels. There was the Toulmin level which worked the debate sentence by sentence. And there was a "higher" overview level of summary of the debate. It was this latter that we used in our first major project (described in case number one below).

Preliminary assessment of overview approach

Our preliminary assessment of the overview approach is that it is quite useful and that the next layer down in detail would be the actual words of the protagonist in the argument, either an excerpt or the complete article or chapter. In our web version, we plan to include such links to source material . Toulmin sentence-by-sentence analysis could also be included at a "deeper" level.

Little has been don by the Intellectual historians so far rather slow to use these argumentation methodologies. Instructors of history and philosophy of artificial intelligence and cognitive science have used the maps to a greater extent. (Horn 1998c, 2000)

Case number one: *Mapping Great Debates: Can Computers Think?*

We wanted to do a major philosophical debate, one that would test the robustness of the overview level of argumentation analysis. I had the vision that it would be a contribution to our common intellectual heritage if we could "map" the great debates both current and past. We picked the Turing debate as to whether computers will ever be able to think as a debate that both had a considerable history since 1950 and appeared to be ongoing. As we analyzed the large, sprawling debate—which turned out to have over 800 claims, rebuttals, and counter-rebuttals—we began to call what we were doing "argumentation mapping" because (as I shall discuss later) the graphic elements loomed large in display. (see Fig. 1 for an example of one of these 7 maps)

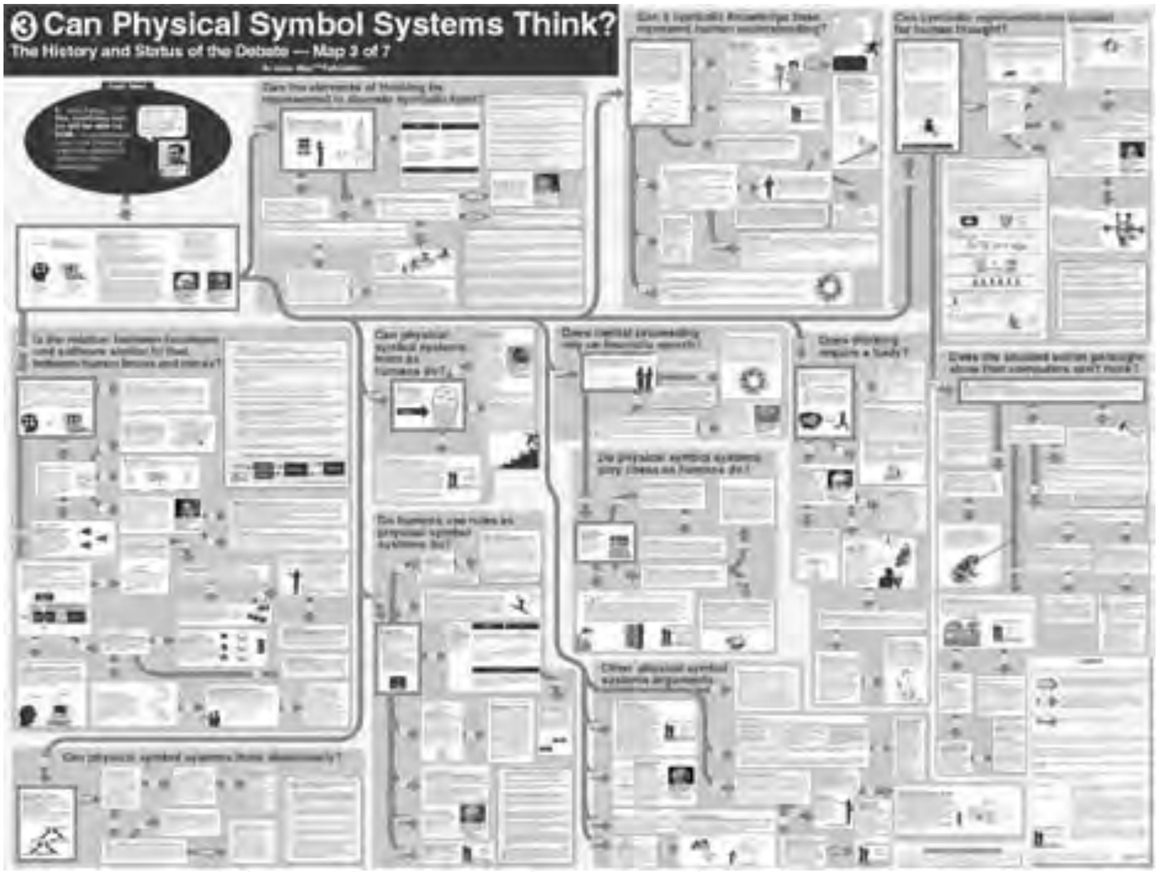

FIGURE 1. This is one of seven maps in the Mapping Great Debates: Can Computers Think? Series. **Reproduced by permission of MacroVU Press.** www.macrovu.com

Claims, supports and disputes

To trace the threads of the arguments we crafted "claims boxes" that contained claims, rebuttals and counterrebuttals. We linked them with arrows that contained the words "is supported by" and "is disputed by." (see Fig.2 for a closeup of a thread of linkages.)

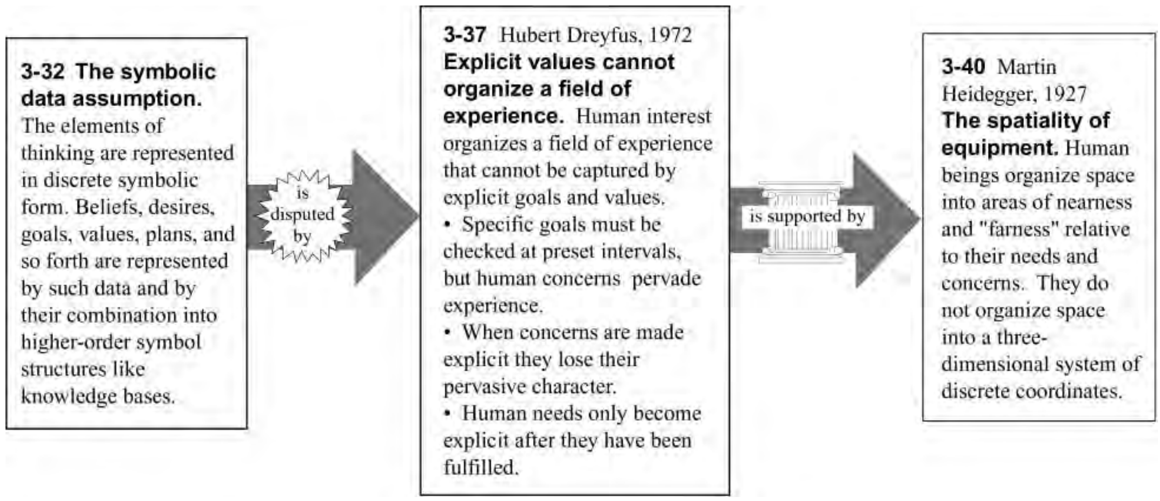

FIGURE 2. This is a closeup of one of the threads of arguments from the Mapping Great Debates series. Reproduced by permission of MacroVU Press.
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How to display both the history and the status of the debates at the same time.

We started out with the goal of showing the status of the debate. That part was relatively easy. All we had to do was read the current articles and see who was answering whom. But we were soon faced with the question of whether to show any current statement of previous claims and rebuttals or to find out who had made the claims first. So within the classification of argumentation analysis described at the beginning of this chapter, there are two criteria that need to be made clear. Criteria one: use the earliest statement of a "move" in the debate. This gives a new type of authentic intellectual history. Criteria two: use the best, or the only available, statement of a "move," which gives a rough-and-ready statement of the argument Both have value depending on your purposes. We chose the earliest-statement criteria so as to satisfy our own wish to provide intellectual history.

Criteria for inclusion of "moves."

Over a considerable period of time, we developed criteria for the Mapping Great Debates series. Such criteria for inclusion and exclusion of moves are essential to the integrity of an argumentation map. Our final group:

1. Use only published arguments.

We decided to include only "moves" that were published in an established print or electronic medium: journals (including reputable electronic journals and white papers), magazines, and books. Arguments made in Usenet newsgroups, electronic forums, e-mail exchanges, or in interpersonal debate were excluded as too ephemeral and as representing positions still in development.

2. Use only arguments that lie within the scope of the map.

The major claim—that machines can or will be able to think—determines the scope of these maps. We excluded any threads of arguments that drifted away from the central issue into such related territories as the mind–body problem, functionalism, and the philosophy of science.

3. Seek out the historically earliest or best-known version of an argument.
When different authors make similar arguments, we chose the version which was historically earliest. In a few cases, we used the best-known version of the argument. When the best-known version was used, the historically earliest version is usually mentioned in a note. In the few cases in which differing versions of an argument are sufficiently unique or separately disputed, each is summarized separately.

4. Avoid loosely drawn arguments.
Sometimes an author makes an argument loosely, at the end of a paragraph, as an aside, or in a footnote. In general, such arguments are not included unless they are developed further in follow-up articles or are the focus of further debate.

5. Avoid repetitive, nitpicking, or duplicative arguments.
One goal of the maps is to facilitate *productive* debate. *Ad hominem* arguments, redundant rounds of back-and-forth, and tediously nitpicky arguments were left out.

6. Avoid forbiddingly technical discussion.
There is a significant domain of highly technical arguments in logic and mathematics (mostly having to do with the Godel debates), which are based on extensive symbolic notation and formalisms, that could not be represented easily with the cartographic conventions we developed, or at the scale at which we chose to work. This was a difficult decision to make. I do not think that such highly mathematical arguments are in principle impossible to characterize in argumentation maps. However, it was difficult to map them within the limits of our paper poster format. Our compromise solution to this problem was to write *summaries* of many technical and symbolic discussions. Only the most forbidding (perhaps 2 or 3) had to be excluded entirely.

7. Summarize the author's published claim.
Many authors hold views today that are different from those they expressed at the time they entered into the debate. To be historically accurate, we included authors' claims *as published*. If an author later changed his or her position and published the change, the new claim was included, and the change of position was noted.

8. Avoid tentative arguments.
The tentative style of some academic writing often makes it extremely difficult to understand exactly what is being argued. Authors had to be definitive in their arguments to qualify for inclusion on the map.

9. Include some rather ancient historical arguments.
In order to properly situate the debate in its historical context, we included a sampling of notable historical philosophical supports for contemporary arguments such as arguments from Leibnitz and Descartes.

10. Include some experimental results.
To situate the debate in a context of concrete experimental and computational results, we included some implemented systems and empirical results. Again, we only included a small sample of such results, sticking to famous and notable computer models and experiments.

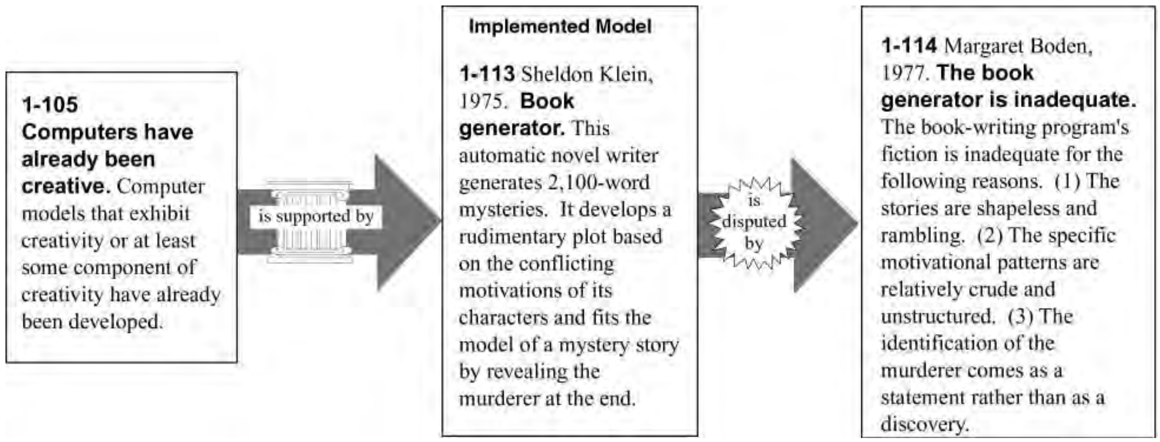


FIGURE 3. This is an example of a claims box showing how claims about experimental results were used in argumentation maps. Reproduced by permission of MacroVU Press. www.macrovu.com

11. Include a small sample of outrageous and humorous arguments.
Some of the stranger claims were worth including just to liven things up and have some fun. Such claims also provide potential "targets" for lively threads of response.

Problem: How exactly to phrase arguments.

Claims can be written with great clarity or can be hopelessly confusing. We found that writers need to be continuously reminded to write the claims in simple declarative sentences. It is very easy for academic writers to hopelessly complicate sentences. This does not make for good argumentation mapping. Many is the time that our writers remarked that they wished that the debate protagonists whom they were summarizing would have written in such a succinct style.

Problem: How to design large displays.

As it turned out, we decided to use paper posters for our initial display. Each of the seven posters measures 3 x 4 feet. Initially, we didn't know which method of spreading out the claims and rebuttals would be better for display. Our criteria here was: How easy is it the initial learner to "get into" the maps. We tested several versions. Top down? Bottom up? Center Outward? Which way should the arrows go: left-to-right or right-to-left?

Start-at-the-top and go-left-to-right appeared best. We tried several linking words and chose "is disputed by" and "is supported by" as our best option for clarity. These words effectively link the claims, supports, and dispute boxes, and also remind the reader of how to read the arrows.

Each of the seven maps present 100 or more major claims, rebuttals and counterrebuttals, each of which is summarized succinctly and placed in visual relationship to the other arguments that it supports or disputes. Claims are further divided into more than 70 issue areas, or major branches of the arguments, each organized around a question. (See figure 2) Arguments by nearly 400 cognitive scientists, philosophers, AI researchers, and mathematicians, and a half-dozen other specialties who have weighed into the argument in a significant way are represented on the maps.

This approach appears to continue to have value. We have built two conference rooms at Stanford University that have large wall-size computer-managed display screens. They are different from the usual projection devices in that every place on the wall has the

resolution for approximately 10-point type. This resolution makes it possible to display large argumentation maps of the kind we have created. One early experiment with computer display showed the value of putting the maps on such screens.

The didactic opportunities abound. One can create software commands that say, "Show all of arguments by protagonist (x)." "Show the arguments in a single timeline instead of 70 issue-area timelines." "Show all of the arguments by protagonists from worldview (y)." These and many more computable variations will make the argumentation map a very flexible tool for educational situations. We hope to implement these in the near future.

How to graphically design the claims?

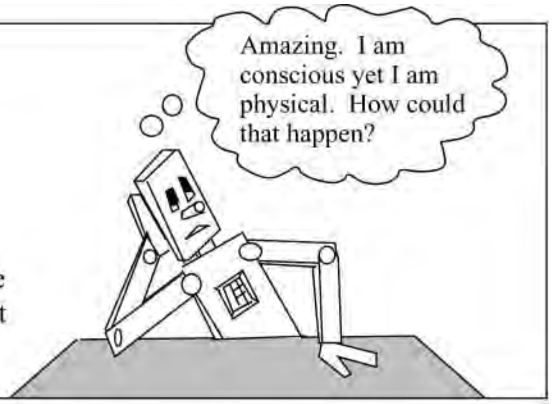
In extremely complex arguments, it is essential to use all the graphic tools available to clarify the debates and, thus, help the reader maneuver through the web of claims and rebuttals. The essential tool is a short title in boldface type for every claim and rebuttal. This improves initial scanning of the argument and also aids retracing one's steps through the debates. Earlier research (Horn, 1989, 1992, Hartley Trueman (1983) Reid &Wright, 1973) has shown that these kinds of subheads or titles provide "prechunking" that helps the reader overcome human shortcomings of working (or short-term) memory.

Our graphic approach is constructed on the syntactic and semantic analysis found in Horn 1998b. We used illustrations to (1) aid exposition of difficult topics (2) serve as examples (3) aid navigation. First, for some difficult topics, a diagram provides exceptional clarity and ease of understanding. Secondly, graphic illustrations that provide examples of the sometimes abstract and abstruse arguments give the reader welcome assistance. These graphics must be used if the maps are to achieve maximum usefulness to learners. Thirdly the rich use of visual icons, illustrations, and examples significantly aids readers' navigation of the argument. During the evaluation period, we frequently heard: "I remembered the drunken Norwegian argument's icon." "I could remember where the argument fit in and where to go back to find it."

It has become our practice to write the claims and rebuttals first, and then to add graphic illustrations. But one should not conclude from this sequence that the visuals are not tightly integrated with the verbal elements. Rather, this is simply a work process simplification, and often in this process, the verbal elements are modified to synchronize with the graphic elements.

In the final version of the *Can Computers Think?* maps, we used several hundred icons and illustrations and about 60 photographs. Figure 4 shows examples of some kinds of illustrations we used to enhance the claims boxes.

6-53 Keith Gunderson, 1985. **The perplexity condition.** If a machine is to be considered conscious, it must be perplexed by its own consciousness. It must be able to wonder, "How is it that I am conscious?"



4-18 Anticipated by John Searle, 1980a, 1980b, 1990b. **The systems reply.** We can consider the person in the room as part of a total system that includes the rule book, scratch paper, and data banks of Chinese symbols. The whole system, not only the person, should be regarded as understanding Chinese.

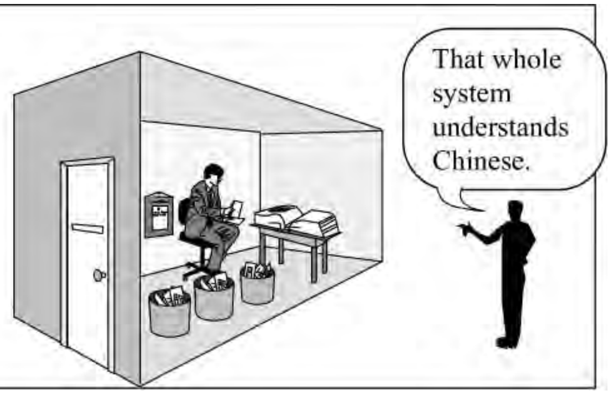


FIGURE 4. Examples of illustrated claims boxes from the Mapping Great Debates series. **Reproduced by permission of MacroVU Press.** www.macrovu.com

How to structure massive arguments?

An argument with 800 major moves defies most human ability to comprehend and manage. It became clear early in our process that the arguments clumped around themes. Our strategy was to let the data determine the clumps. That is, we worked from the bottom up rather than trying to impose a scheme of logically delineated themes.

At several points we found that there were references in the articles we were reading to "those who claim (x)" -- offered without citation. In fact it happened so often that we had threads of debates -- claims, rebuttals, counterrebuttals -- with no one to attribute the initial claim to. We finally assumed that much of the debate we were tracing was woven around conferences, meetings, and live debates where individuals asserted these major claims but no one bothered to put them in writing. Yet, for the linking together of arguments about a given theme, something more was needed. So we had to violate our "use only published sources" criterion to give the map regions sufficient coherence. At last, we invented what we call the "focus box" which was a statement of a claim for which we did not actually find a statement by some specific protagonist. These focus boxes were then used to initiate issue areas.

6-76 Dieter Birnbacher, 1995
Consciousness might still be necessary. Just because there isn't a perfect correlation between thinking events and consciousness events doesn't mean that consciousness is unnecessary for thinking. Consciousness might still be necessary for thinking in general, though not necessarily attached to each thinking event.

FIGURE 5. Example of a focus box from the Mapping Great Debates series.
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For several years during the time we were making these maps, we simply used words like "emotional arguments" or "creativity arguments" to clump the debates. As we began the final designs of the maps, it was suggested by a colleague that we translate the themes into questions to act as headlines for the regions (e.g. Can computers be creative? Can computers have emotions?). This has become our standard practice.

Problem: How to represent and incorporate worldviews.

One of the difficult aspects of understanding great debates like this one is that the protagonists come from quite different points of view. They bring vastly different assumptions about the nature of reality. Often, in a specific article, the protagonists do not reveal their assumptions or their affiliation with a specific camp of thinkers. We have tried to provide a tool for learners here also. The basic clue was provided by Simon and Newell's listing of their postulates for the representationist point of view, which they call the physical symbol system hypothesis. (See Table 2) We then wrote sets of postulates for nine other major points of view and have included them on the various maps. We identified, where possible, which participants on the maps could be regarded as being part of a specific camp, thereby providing students with an insight as to why particular arguments might be taking place.

For us, it is still a research topic as to how to incorporate these postulates usefully onto web versions of the maps. It is also a creative project for our field to try to imagine a different sort of graphic display for worldviews than our lists of postulates.

Postulates of the Physical Symbol Systems Hypothesis

1. A physical symbol system
   - is physical (that is, made up of some physical matter)
   - is a specific kind of system (that is, a set of components functioning through time in some definable manner) that manipulates instances of symbols.

2. Symbols can be thought of as elements that are connected and governed by a set of relations called a symbol structure. The physical instances of the elements (or tokens) are manipulated in the system.

3. An information process is any process that has symbol structures for at least some of its inputs or outputs.

4. An information processing system is a physical symbol system that consists of information processes.

5. Symbol structures are classified into
   - data structures
   - programs.

6. A program is a symbol structure that designates the sequence of information processes (including inputs and outputs) that will be executed by the elementary information processes of the processor.

7. Memory is the component of an information processing system that stores symbol structures.

8. Elementary information processes are transformations that a processor can perform upon symbol structures (e.g., comparing and determining equality, deleting, placing in memory, retrieving from memory, etc.).

9. A processor is a component of an information processing system that consists of:
   - a fixed set of elementary information processes,
   - a short-term memory that stores the input and output symbol structures of the elementary information processes, and
   - an interpreter that determines the sequence of elementary information processes to be executed as a function of the symbol structures in short-term memory.

10. The external environment of the system consists of "readable" stimuli. Reading consists of creating internal symbol structures in memory that designate external stimuli. Writing is the operation of emitting the responses to the external environment that are commanded by the internal symbol structures.

Adapted from Newell and Simon (1972, chap. 2).

Proponents include Jerry Fodor, Allen Newell, Herbert Simon, John McCarthy, Zenon Pylyshyn, early Marvin Minsky, Doug Lenat, Edward Feigenbaum, and Pat Hayes.

TABLE 2. Example of Postulates. **Reproduced by permission of MacroVU Press.**
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How to incorporate ancillary information?

In developing the argumentation maps as a teaching and research tool, we recognized that the bare-bones, stand-alone argumentation map is insufficient. Students new to the area need supplementary information to enable them to fully comprehend the arguments. They need, for example, definitions and historical background. They need to have a Turing machine explained to them. We imbedded a variety of sidebars onto the maps to provide access to this information. The definitions have the visual look and feel of a dictionary entry. In the end, we included 50 definitions and 32 sidebars on the 7 maps. These are located at strategic spots in the maps close to where the topics and terms are introduced. As we have migrated some of the maps onto the web, these have become clickable topics. It is very important in developing such ancillary blocks of information to clearly label them by type (e.g. definitions, historical notes, etc.)

How to incorporate secondary links?

We found, for example, that many of the arguments used for and against the von Neuman architecture (the kind of internal design of ordinary computers on our desks) and the arguments for and against connectionist networks (computers that are built around a structure similar to that of interlinked neurons) were quite analogous. Yet the arguments about connectionist architecture of computers took up half of map 5 and the sprawling arguments about von Neuman architecture covered maps 3 and 4. It seemed important to somehow show these similarities of argumentation threads to learners. There were other situations like this that appeared widely separated in the argumentation networks. We developed a set of secondary links which help readers tie together such important connections. On the paper versions, they were simple statements. For an example, see Figure 6. It is much easier to develop these secondary linkages in a software hypertext environment.

3-45 Joseph Rychlak, 1991

Learning is process of interpretation. Most AI theorists model learning on a Lockean paradigm that takes repetition and contiguity of perceptions as the primary way in which new concepts are learned. For example, we learn how to spell by repeatedly seeing how words are spelled and which letters are contiguous to each other. But such a model does not pay sufficient attention to the role of meaning in learning. Learning occurs when a mind that reasons dialectically and predicationally interprets what it perceives in terms of the meaning of what it perceives. Because computers don't work with meanings, interpretation and the relevant kind of learning is impossible for them. Note: Rychlak's further arguments about artificial intelligence can be found in the "Can physical symbol systems think dialectically?" arguments on this map.

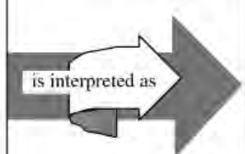
4-28 The man in the Chinese Room doesn't instantiate a program. A human being (or a homunculus) shuffling symbols in a room is not a proper instantiation of a computer program, and so the Chinese Room argument does not refute AI.
Note: For more multiple realizability arguments, see the "Is the brain a computer?" arguments on Map 1, the "Can functional states generate consciousness?" arguments on Map 6, and sidebar, "Formal Systems: An Overview," on Map 7.

FIGURE 6. Examples of secondary links from the Mapping Great Debates series. **Reproduced by permission of MacroVU Press.** www.macrovu.com

What happens when there is a variation of a claim?

In some instances an author makes a distinctive and crucial shift in the definition of an issue, yet is clearly arguing with a specific protagonist. We had to indicate that a major shift in ground had taken place. When such a distinctive reconfiguration of an earlier claim was made, we used a different icon on the arrow with the words "is interpreted as." (See Figure 7 for an example)

2-69
The Turing test provides a behavioral/operational definition of intelligence. The Turing test defines thinking in terms of overt, measurable behavior. It offers a behavioral/operational definition of our ordinary concept of thinking. Disputed by "A Box of Rocks Could Pass the Toe-Stepping Game," Box 7.
Note: A similar debate takes place in the "Is passing the test decisive?" arguments on this map, which deal with the question of what can be demonstrated by successful simulation.



2-83 Anticipated by Ned Block, 1981
The behavioral disposition interpretation. A system is intelligent if it is behaviorally disposed to pass the Turing test. In this interpretation, neither passing the test nor failing the test is conclusive, because intelligence doesn't require passing but only a disposition to pass.

FIGURE 7. Example of "is interpreted as" link from the Mapping Great Debates series. **Reproduced by permission of MacroVU Press.** www.macrovu.com

Value of CSCA in interdisciplinary navigation.

Our work on the *Mapping Great Debates: Can Computers Think?* series has opened up the development of a new field for the understanding of intellectual history. Among other advances, it illuminates the important history of how new concepts and distinctions in intellectual endeavors arise out of debate. Still to be worked out on the web-based versions are how to build instructional modules around the argumentation maps which would serve as the navigational core. However, the argumentation structure aids students, as well as researchers and scholars from outside a field, who, of course, become students once they enter an unfamiliar field.

Pedagogical Implications

The argumentation maps are beginning to be used in a wide variety of ways in the classroom. It requires considerable rethinking for the instructor to change familiar classroom lecture and question routines to implement them to full use. But they offer the opportunity for innovative assignments ranging from (1. relatively easy) choosing one of the 70 major branches of the debate and writing a paper agreeing or disagreeing, to (2 moderately more difficult) asking students to rank order the strength of different debates on a given branch and consider why they give the weights they do to the different arguments, to (3. more advanced) asking students to come up with at least one new argument at the end of one of the branches, which represent the frontiers of the debate, to (4. even more advanced) asking students to write a paper that shows why two or more of the eleven philosophical camps described in postulates on the maps are debating a particular issue.

One professor told me that he had always had difficulty explaining to graduate students about how to select and narrow topics for philosophy dissertations. With the maps he was able to show the amount and depth of coverage quite easily simply by waving his hands over parts of the maps.

Opportunity to see major disagreements
The biologist Lewis Thomas, who wrote, "College students, and for that matter high school students, should be exposed very early, perhaps at the outset, to the big arguments currently going on among scientists. Big arguments stimulate their interest, and with luck engage their absorbed attention... But the young students are told very little about the major disagreements of the day; they may be taught something about the arguments between Darwinians and their opponents a century ago, but they do not realize that similar disputes about other matters, many of them touching profound issues for our understanding of nature, are still going on, and, indeed are an essential feature of the scientific process." This will become over the next few years the biggest impact for teaching and learning from the use of argumentation maps.

Provide context and visible structure
As we noted in Horn (2000): "We live in an age of information overload and specialization. The sheer numbers of argumentative moves (over 800); the number of authors represented on the maps (380); the number of sources that we consulted (over 1,000) and the sources that contained original arguments used in the maps (over 400) are overwhelming to the student undertaking study in this area.

One graduate student in the philosophy of mind said: "These maps would have saved me 500 hours of time my first year in graduate school. For almost two semesters, I had to keep reading article after article without enough context to see how they fit in to the bigger picture. The maps would have made my whole experience a much more rewarding one."

It was also interesting to hear from a professor of philosophy of mind who had begun using the maps in her teaching. She reported that "The maps have, in fact, prompted me to reorganize my Philosophy of Mind course to cover certain issues and problems from a particular approach, using the commentaries of thinkers noted on the maps--e.g. the Chinese Room in more depth, and connected more explicitly to the question 'Can Computers Think?'" (Wagner, 1998)"

Evaluations needed
At this point, the evaluations of classroom use of our argumentation maps has been limited to observations by teachers and anecdotal feedback. The maps have been laminated and hung on walls in classrooms. They have been put in the library on reserve.

They've been spread out on the seminar room table. A recurrent recommendation has been that they would be more frequently used if they were in some electronic form. But almost as soon as a professor suggests electronic form they take back the recommendation with the words "of course, then you wouldn't get the benefit of seeing the structure of the arguments that the maps provide." This can only be solved by larger screeens.

Case number two: Genetically modified food

Science and science policy.

Society needs to be able to continuously evaluate new potentially disruptive knowledge and technologies. We were commissioned by *New Scientist* magazine to look into the question of how to create a web display of our maps on a science policy project. We were given the topic of the debates about genetically modified food and requested to investigate a prototype.

What was interesting was the arrangement of the top level--how the topic was "framed" by the questions asked. How the top level framing of the policy questions look on the web is shown in Figure 8.

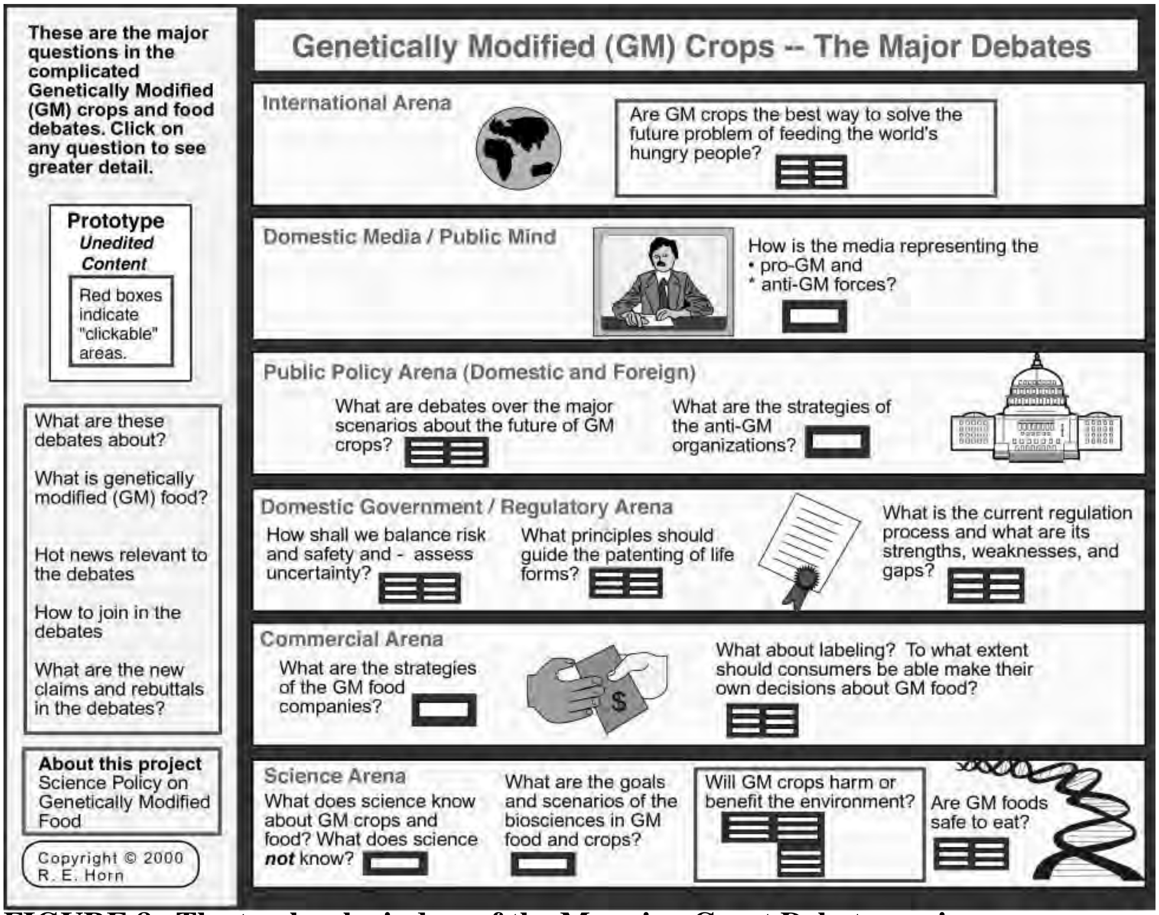


FIGURE 8. The top level window of the Mapping Great Debates series on Genetically Modified Food. **Reproduced by permission of MacroVU Press. www.macrovu.com**

How to display extensive argumentation on the web?

Displaying extensive argumentation on the web within the confines of small screens is difficult. Initially we tried simply to put our maps on the web as they were presented in print format. But debates of more than a few moves produced much difficulty for the reader to stay oriented. Once into the middle of the visual space, the reader had difficulty tracing the arguments back. As this chapter goes to press, we are experimenting with a vertical format illustrated in Figure 9.

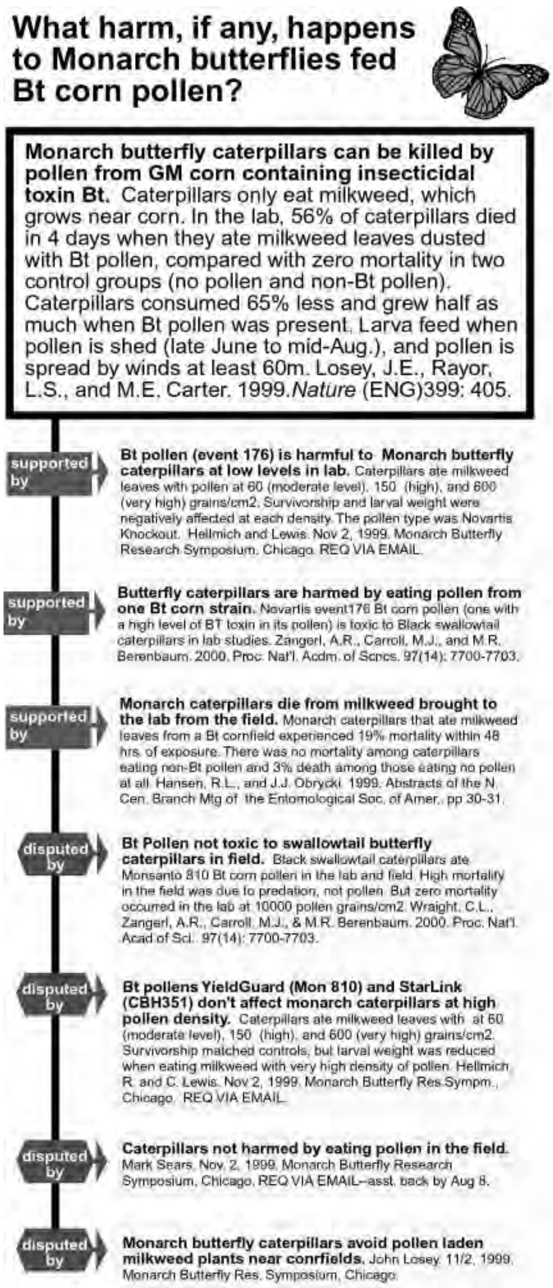


FIGURE 9. The vertical format of the Mapping Great Debates series on Genetically Modified Food. **Reproduced by permission of MacroVU Press.** www.macrovu.com

The genetically modified food project did not receive any formal evaluation as it was done as a prototype project. We are in the process of seeking support to evaluate its use in public policy development.

Case number three: Consciousness research

How to display different entry points?

We received a grant several years ago to create prototype argumentation maps in the rapidly expanding discipline of consciousness studies. This presents a different problem from that of the Turing debates. The debates are all focused on the same phenomena -- consciousness -- but different disciplines start with quite different questions. What this has meant for mapping the debate is that there can not be a single determining question, such as appears in the Turing debates (i.e. Can Computers Think?) So, we have provisionally decided to simply cluster questions. Our first group of questions are the philosophical ones, and as a top-level web page can be seen in Figure 10.

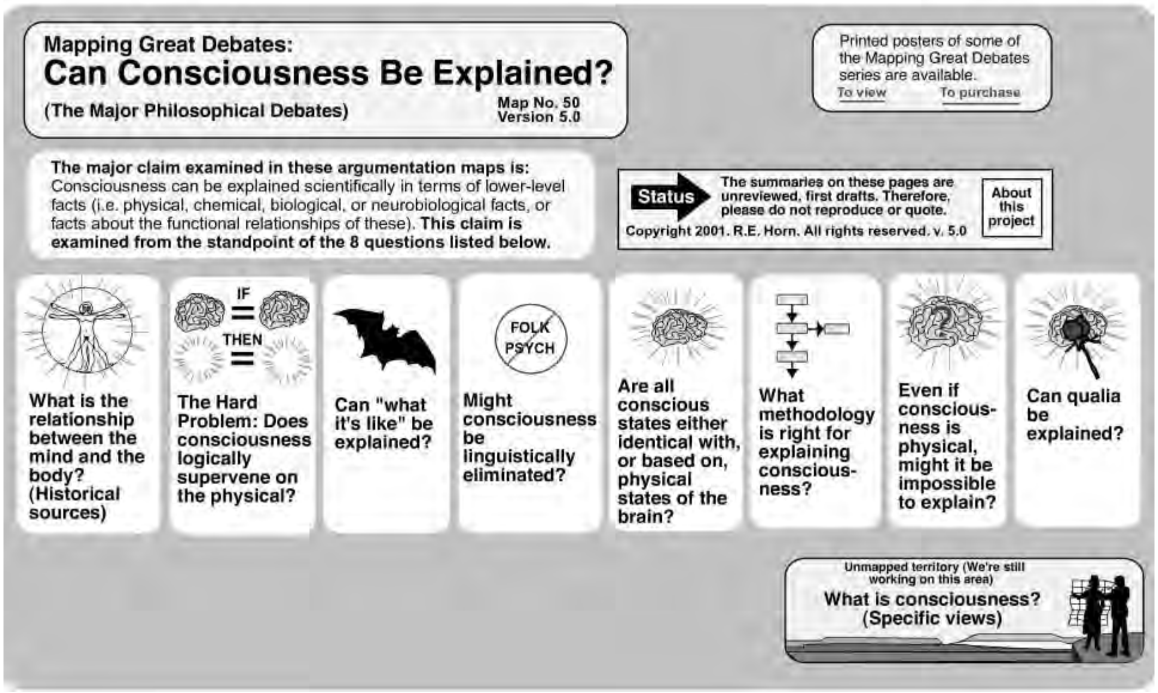


FIGURE 10. The vertical format of the Mapping Great Debates series on CONSCIOUSNESS. **Reproduced by permission of MacroVU Press.** www.macrovu.com

It is clear that questions emanating from neuropsychology will start from quite different places.

How to build infrastructure collaboratively?

As this chapter is written, we have begun to work on the issue of how to involve graduate students in collaboratively creating maps. Clearly there needs to be a course to help bring students into the conventions and criteria used in the mapping. In addition we need to provide some kind of content and editorial review of their summaries of moves. We are not interested in developing a chatroom. The content review needs to be done by specialists. The editorial review needs to be of two kinds: the writing of the actual sentences summarizing claims, and the linkages. How this will all be managed on the web is yet another research problem. We imagine using some form of annotation functionality in the software.

Conclusion: Our vision

We envision the ability over time to witness the creation of vast webs of argumentation maps on the web that cover many fields and that show us how humanity working together has asked, debated, and sometimes even answered the Great Questions.

Acknowledgements

I want to salute the members of my team--Jeff Yoshimi, Mark Deering, (of the University of California, Irvine) and Russ McBride (University of California, Berkeley)--without whose dedicated effort and creative thought these maps would not be what they are today. I also want to thank the publishers, MacroVU, Inc. and the Lexington Institute, for their generous support of the Can Computers Think? project. I further salute Paul Livingston as the primary writer in our project on consciousness. I further want to thank The Consciousness Studies Program of Arizona University for support (through a grant from the Fetzer Institute) of the Consciousness Project. And finally, I want to express appreciation to *New Scientist* magazine for support of the Genetically Modified Food project, and to project analysts Ben Shouse and Shirley Dang.

Notes

1. Our project began in the mid-80s. The work I had done on the Information Mapping (1) method of structured writing and analysis is a successful attempt to carefully delineate a taxonomy and later a life-cycle document-creation methodology for relatively stable subject matter. (Horn, 1989, 1992a , 1992b, 1993, 1995) Relatively stable subject matter is that which doesn't change much and about which there is little dispute. Information Mapping's method is widely used in industry and government for writing documentation, training, procedures and policies, and reports. Information Mapping is a registered trademark of Information Mapping, Inc. see <www.informap.com>

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2003
Visual Language

by Robert E. Horn

A chapter “Visual Language and Converging Technologies in the Next 10-15 Years and Beyond” from Roco, C. and Bainbridge, W. S., Eds. *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science,* Kluver Academic, 2003

Visual Language and Converging Technologies in the Next 10-15 Years (and Beyond)

A paper prepared for the National Science Foundation Conference on Converging Technologies (Nano-Bio-Info-Cogno) for Improving Human Performance Dec. 3-4, 2001

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Background

Introduction

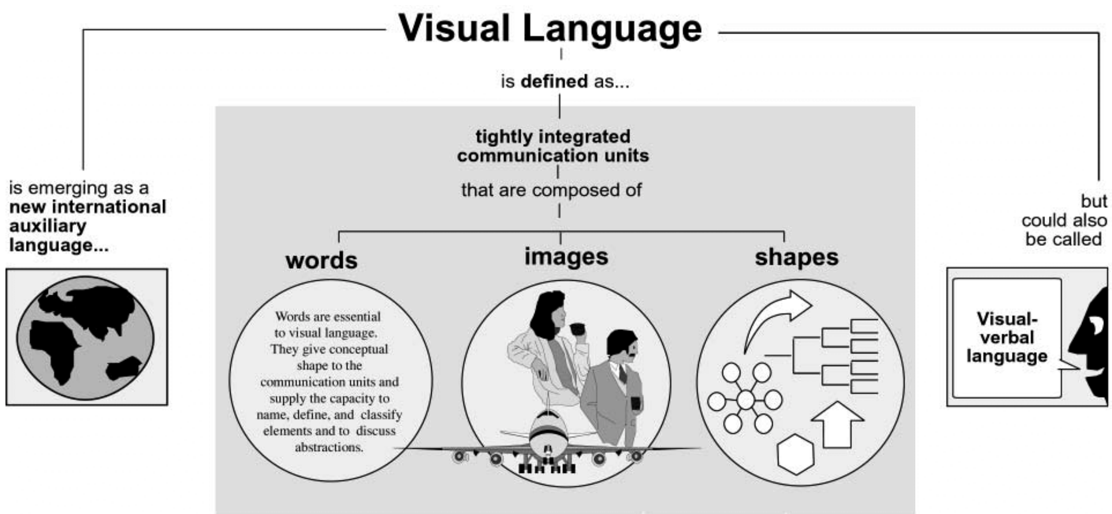
Visual Language is one of the more promising avenues to the improvement of human performance in the short run (the next 10 to 15 years). The current situation is one of considerable diversity and confusion as a new form of communication arises. But visual language also represents many great opportunities. People think visually. People think in language. When words and visual elements are closely intertwined, we create something new and we augment our communal intelligence.

Today, human beings work and think in fragmented ways, but visual language has the potential to integrate our existing skills to make them tremendously more effective. With support from developments in information technology, visual language has the potential for increasing human "bandwidth," the capacity to take in, comprehend, and more efficiently synthesize large amounts of new information. It has this capacity on the individual, group, and organizational levels. As this convergence occurs, visual language will enhance our ability to communicate, teach, and work in fields such as nanotechnology and biotechnology.

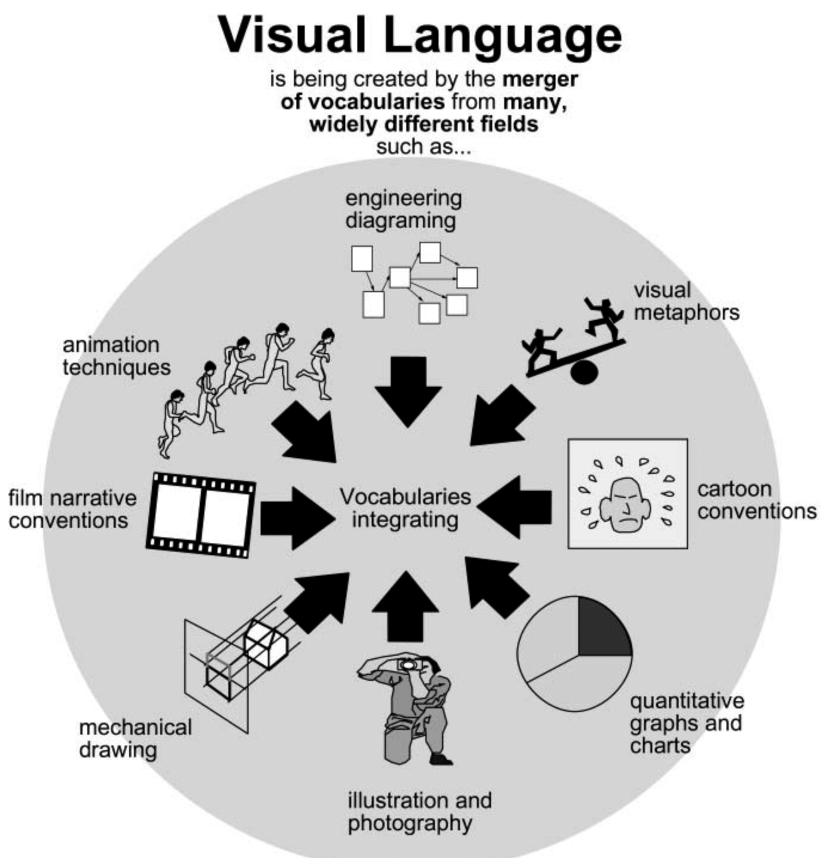
Definition

Visual language is defined as the tight integration of words and visual elements and as having characteristics that distinguish it from natural languages as a separate communication tool as well as a distinctive subject of research. It has been called visual language although it might well have been called visual-verbal language.

A preliminary syntax, semantics, and pragmatics of visual language have been described. (Horn, 1998) Description of, understanding of, and research on visual language overlap with investigations of scientific visualization and multimedia.

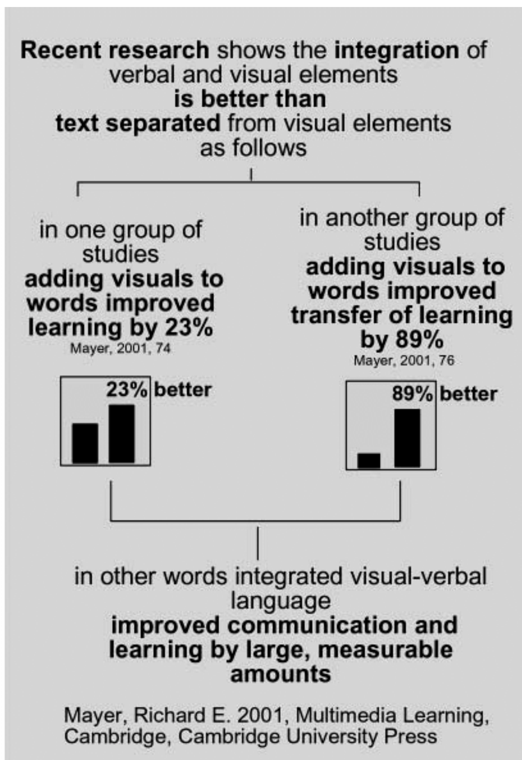


History
The tight integration of words and visual elements has a long history. (see Horn, 1998, Chapt. 2) Only in the last 50 years, with the coming together of component visual vocabularies from such widely separate domains as engineering diagramming technologies developed in medical illustration, and hundreds of expressive visual conventions from the world of cartooning has something resembling a full, robust visual-verbal language appeared. (Tufte, 1983, 1990)



Its evolution has been rapid in the past 10 years, especially with the confluence of scientific visualization software; widespread use of other quantitative software that permits the creation of over one hundred quantitative graphs and charts with the push of a single function key; and the profusion of multi-media presentation software, especially PowerPoint which, it is said, has several million users a day.

More effective communication
There is widespread understanding that visual-verbal language enables forms and efficiencies of communication that heretofore have not been possible. For example, improvements in human performance from 23 to 89% have been obtained by using integrated visual-verbal "stand- alone" diagrams. In this case, "stand-alone" diagrams refer to diagrams that have all of the verbal elements necessary for complete understanding without reading text elsewhere in a document. (Chandler and Sweller, 1991; Mayer 2001, Horton, 1991)



Facilitates representation. This new language facilitates complex, multi-dimensional visual-verbal thought, and -- with multimedia tools -- it incorporates animation as well. Researchers and scholars are no longer constrained by the scroll-like thinking of endless paragraphs of text.

Big, complex thoughts. Human cognitive effectiveness and efficiency is constrained by the well-known limitations of working memory that George Miller identified in 1957 (Miller 1957). Large visual displays have for some time been known to help us overcome this bandwidth constraint. But only since the recent advances in visual

language have we been able to imagine a major prosthesis for this human limitation. The prosthesis consists of a suite of visual language maps. This visual-verbal language (together with computer-based tools) may eliminate the major roadblocks to thinking and communicating big, complex thoughts — i.e. the problem of representing and communicating mental models of these thoughts efficiently and effectively. This especially includes the so-called messy (or wicked or ill-structured) problems. (Horn, 2001a) Problems have solutions. Messy problems do not have straightforward solutions.

They are
- more than complicated and complex. They are ambiguous.
- filled with considerable uncertainty — even as to what the conditions are, let alone what the appropriate actions might be
- bounded by great constraints; tightly interconnected economically, socially, politically, technologically
- seen differently from different points of view, and quite different worldviews
- comprised of many value conflicts
- often a-logical or illogical.

These problems are among the most pressing for our country, for the advance of civilization, and for humanity.

Premises
The deep understanding of the patterns of visual language will permit
- More rapid, more effective interdisciplinary communication
- More complex thinking, leading to a new era of thought
- Facilitation of business, government, scientific, and technical productivity
- Potential breakthroughs in education and training productivity
- Greater efficiency and effectiveness in all areas of knowledge production and distribution
- Better cross-cultural communication

Ready for major research and development. Major jumping-off research platforms have been created for rapid future development of visual language e.g. the Web; the ability to tag content with XML; database software; drawing software; a fully tested, widely used content-organizing and tagging system of structured writing known as Information Mapping¤ (Horn, 1989); and a growing, systematic understanding of the patterns of visual-verbal language. (Kosslyn, 1989, 1994; McCloud, 1993, Horton, 1991, Bertin, 1983)

Rationale for the visual language projects
A virtual superhighway for rapid development in visual language can be opened and the goals listed above in the premises can be accomplished if sufficient funds over the next 15 years are applied to the creation of
- Tools
- Techniques
- Taxonomies

and systematically conducting empirical research on effectiveness and efficiency of components, syntax, semantics, and pragmatics of this language. This in turn will aid the synergy produced in the convergence of biotechnology, nanotechnology, information technology, and cognitive science.

Some of the goals of a visual-verbal language research program

A research program requires both bold, general goals and specific landmarks along the way. A major effort to deal with the problem of increasing complexity and the limitations of our human cognitive abilities would benefit all human endeavors, and could easily be focused on biotechnology and nanotechnolgy as prototype test beds. We can contemplate, thus, the steady incremental achievement of the following goals as a realistic result of a major visual language program:

1. **Policy-makers provided with comprehensive visual-verbal models**. The combination of the ability to represent complex mental models and the capability of collecting real-time data will provide sophisticated decision-making tools for social policy. Highly visual 'cognitive maps' will facilitate the management and navigation through major public policy issues. These maps provide patterned abstractions of policy landscapes that permit the decision-makers and their advisors to consider which roads to take within the wider policy context. Like the hundreds of different projections of geographic maps (e.g. polar or Mercator), they provide different ways of viewing issues and their backgrounds. They enable policy makers to drill down to the appropriate level of detail. In short, they provide an invaluable information management tool.

2. **World-class, worldwide education provided for children.** Our children will inherit the results of this work. It is imperative that they receive the increased benefits of visual language communication as soon as it is developed. The continued growth of the internet and the convergence of intelligent visual-verbal representation of mental models and computer-enhanced tutoring programs will enable children everywhere to learn the content and skills needed to live in the 21st century. But this will take place only if these advances are incorporated into educational programs as soon as they are developed.

3. **Large breakthroughs in scientific research.** The convergence of more competent computers, computer-based collaborative tools, visual representation breakthroughs, and large databases provided by sensors will enable major improvements in scientific research. Many of the advances that we can imagine will come from interdisciplinary teams of scientists, engineers, and technicians who will need to become familiar rapidly with fields that are outside of their backgrounds and competence. Visual language resources (such as the diagram project described below) will be required at all levels to make this cross-disciplinary learning possible. This could be the single

most important factor in increasing the effectiveness of nano-bio-info teams working together at the various points of convergence.

4. **Enriched art of the 21st century.** Human beings do not live by information alone. We make meaning with our entire beings: emotional, kinesthetic, somatic. Visual art has always fed the human spirit in this respect. And we can confidently predict that artistic communication and aesthetic enjoyment in the 21st century will be enhanced significantly by the scientific and technical developments in visual language. Dynamic visual-verbal murals and art pieces will become one of the predominant contemporary art forms of the century — as such complex, intense representation of meaning joins abstract and expressionistic art as a major artistic genre. (This has already begun to happen with the artists creation of the first generation of large visual language murals. Horn, 2000)

5. **Emergence of smart, visual-verbal thought software.** The convergence of massive computing power, thorough mapping of visual-verbal language patterns, and advances in other branches of cognitive science will provide for an evolutionary leap in capacity and multi-dimensionality of thought processes. Scientific visualization software in the past 15 years has led the way in demonstrating the necessity of visualization to the scientific process. We could not have made advances in scientific understanding in many fields without software that helps us convert "firehoses of data" (in the vivid metaphor of the 1987 National Science Foundation report on scientific visualization) into visually comprehensible depictions of *quantitative* phenomena and simulations. Similarly, every scientific field is overwhelmed with tsunamis of new *qualitative* concepts, procedures, techniques, and tools. Visual language offers the most immediate way to address these new, highly demanding requirements.

6. **Wide open doors of creativity.** Visualization in scientific creativity has been frequently cited. Einstein often spoke of using visualization on his gedanken experiments. He saw in his imagination first and created equations later. This is a common occurrence for scientists, even those without special training. Visual-verbal expression will facilitate new ways of thinking about human problems, dilemmas, predicaments, emotions, tragedy, and comedy. The limits of my language are the limits of my world, said Wittgenstein. But it is in the very nature of creativity for us to be unable to specify what the limits will be. Indeed, it is not always possible to identify the limits of our worlds until some creative scientist has stepped across the limit and illuminated it from the other side.

Researchers in biotechnology and nanotechnology will not have to wait for the final achievement of these goals to begin to benefit from advances in visual language research and development. Policy makers, researchers, and scholars will be confronting many scientific, social impact, ethical and organizational issues, and each leap in our understanding and competence in visual language will increase our ability to deal with the complexity. Normally, as a language advances in its ability to handle complex

representation and communication, each such advance can be widely disseminated because of the modular nature of the technology.

Major goals along the way to the next 15 years

The achievement of these goals will obviously require advances on a number of fronts.

1. **Goal: Diagram an entire branch of science with stand-alone diagrams.** In many of the newer introductory textbooks in science up to one-third of the total space consists of diagrams and illustrations. But often, the function of scientific diagrams in synthesizing and representing scientific processes has been often taken for granted. However, recent research cited above (Mayer, 2001, Chandler and Sweller, 1991) has shown how stand-alone diagrams can significantly enhance learning. Stand-alone diagrams do what the term indicates. Everything the viewer needs to understand the subject under consideration is incorporated into the diagram or from other diagrams linked to the one in focus. The implication of the research is that the text in the other two thirds of the textbooks mentioned above should be distributed into diagrams.

   "Stand-alone" is obviously a relative term, because it depends on previous learning. One should note here that automatic prerequisite linkage is one of the easier functions to imagine being created in software packages designed to handle linked diagrams. One doesn't actually have to make too large a leap of imagination as scientists are already exchanging PowerPoint slides that contain many diagrams. However, this practice frequently does not have either the stand-alone or linked property.

   Stand-alones can be done at a variety of styles and levels of illustration. They can be abstract or detailed, heavily illustrated or merely shapes, arrows, and words. They can contain photographs and icons as well as aesthetically pleasing color.

   Now, imagine a series of interlinked diagrams for an entire field of science. Imagine zooming up and down in detail -- always having the relevant text immediately accessible. The total number of diagrams could reach into the tens of thousands. The hypothesis of this idea is that such a project could provide an extraordinary tool for cross-disciplinary learning. This prospect directly impacts the ability of interdisciplinary teams to learn enough of each other's fields to collaborate effectively. And collaboration is certainly the key to benefiting from converging technologies.

   Imagine that these diagrams were *not* dependent on getting permissions (one of the least computerized, most time-consuming tasks a communicator has to accomplish these days). Making permissions automatic would remove one of the major roadblocks to the progress of visual language and a visual language project.

   Then imagine being able to send a group of linked-stand-alone diagrams to fellow scientists.

2. **Goal: Create "Periodic table(s)" of types of stand-alone diagrams.** Once we had tens of thousands of interlinked diagrams in a branch of science, we could analyze and characterize all the components, structures, and functions of all of the types of diagrams. This would advance the understanding of "chunks of thinking" at a fine-grained level. This metaunderstanding of diagrams would also be a jumping-off point for building software tools to support further investigations and to support diagramming of other branches of science and the humanities.

3. **Goal: Automatically create diagrams from text.** At the present moment, we do not know how to develop software that enables the construction of elaborate diagrams of many kinds from text. But if the stand-alone diagrams prove as useful as they appear, then it creating diagrams, or even first drafts of diagrams, from verbal descriptions will turn out to be extremely beneficial. Imagine scientists with new ideas of how processes work speaking to their computers and the computers immediately turning the idea into the draft of a stand-alone diagram.

4. **Goal: Launch Human Cognome Project.** In the Converging Technologies workshop I suggested that we launch a project that might be named "Mapping the Human Cognome Project." If properly conceived, such a project would certainly be a project of the century. If the stand-alone diagram project succeeds, then we would have a different view of human "thought chunks." And human thought-chunks can be understood as fundamental building blocks of the human cognome. The rapid achievement of stand-alone diagrams for a branch of science could, thus, be regarded as a jumping off platform for at least one major thrust of a Human Cognome Project.

5. **Goal: Create tools for collaborative mental models based on diagraming.** The ability to come to rapid agreement at various stages of group analysis and decision-making supported by complex, multidimensional, visual-verbal murals is becoming a central component of effective organizations. This collaborative problem solving, perhaps first envisioned by Douglas Engelbart (1962) as augmenting human intellect, has launched a vibrant new field of computer-supported collaborative work (CSCW). This community has been facilitating virtual teams working around the globe on the same project in a 24/7 asynchronous time frame. An integration of the resources of visual language display, both the display hardware needed and the visual display software, with the interactive possibilities of CSCW work offers the possibilities of great leaps in group effectiveness and efficiency.

6. **Goal: Crack the unique address dilemma with fuzzy ontologies.** The semantic web project is proceeding on the basis of creating unique addresses for individual chunks of knowledge. Researchers are struggling to create "ontologies" (by which they mean hierarchical category schemes, similar to the Dewey system in libraries.) But researchers haven't yet figured out really good ways to handle the fact that most words have multiple meanings. There has been quite a bit of progress in resolving such ambiguities in language translation, so there is hope for further incremental progress and major breakthroughs. An important goal for cognitive scientists and

computer wizards will be to produce breakthroughs for managing multiple, changing meanings of visual-verbal communication units in real-time on the web.

7. **Goal: Understand computerized visual-verbal linkages.** Getting computers to understand the linkage between visual and verbal thought and their integration is still a major obstacle to building computer software competent to undertake the automatic creation of diagrams. This will likely be less of a problem as the stand-alone diagram project described above progresses.

8. **Goal: Crack the "context" problem.** In meeting after meeting, people remark at some point that "it all depends on the context." Researchers must conduct an interdisciplinary assault on the major problem of carrying context and meaning along with local meaning in various representation systems. This may very well be accomplished to a certain degree by providing pretty good, computerized "common sense." To achieve the goal of automatically creating diagrams from text, there will have to be improvements in the understanding of "common sense" by computers. The CYC project or something like it will have to demonstrate the ability to reason with "almost any" subject matter from a base of 50 million or more coded facts and ideas. This common-sense database will somehow be integrally linked to visual elements.

Conclusion

It is essential to accelerating research in the fields of nanotechnology, biotechnology, cognitive science, and information technology to increase our understanding of visual language. We must develop visual language research centers, fund individual researchers, and ensure that these developments are rapidly integrated into education and into the support of the other converging technologies in the next decade.

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Knowledge Mapping
and
Social Messes

by Robert E. Horn

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MAPPING SOCIAL MESSES

ROBERT E. HORN IS CONVINCED A NEW LANGUAGE IS EMERGING THAT BLURS THE LINES BETWEEN CARTOONS AND PROSE, DIAGRAMS AND LABELS, ART AND SCIENCE. A POLITICAL SCIENTIST BY TRAINING AND A KNOWLEDGE CARTOGRAPHER BY PROFESSION, HE TELLS DAVID PESCOVITZ WHY VISUAL LANGUAGE IS CRUCIAL IN OUR INFORMATION-SATURATED SOCIETY, AND HOW HIS "MESS MAPS" CAN HELP DISENTANGLE COMPLEX SOCIAL SITUATIONS.

David Pescovitz: What is the high-level thrust of your work?

Robert Horn: I'm attempting to make communication easier, quicker and more accurate in the face of the immense complexity and information overload that all of us face.

To that end, you evangelize a visual language. What does that mean?

Language is what people use to communicate. If you look at the business and scientific worlds, people tightly integrate words and visual elements to communicate. By visual elements, I mean shapes in the diagrammatic sense and images in the illustrative sense. The critical questions to ask are "What do words do best?" and "What do visual elements do best?" In diagrams, words describe the phenomena, the events, or the objects, and visual elements help separate and connect the parts, while also describing relationships. When they're integrated, you get the ability to manage much more complexity.

What about the aesthetics of your maps?

Aesthetics are important. But in the consulting arena, you can only get as much in terms of aesthetics as the client will pay for. Most of my maps are limited by time and the clients usually don't have huge budgets. We try to make the maps pleasant to look at. We have our own database of clip-art and, with each project, we can usually afford to make a few new icons. As we accumulate icons, the maps get prettier.

A graphic designer would argue that the aesthetics of the map dramatically impacts not only its function, but also its usability. Your maps are not as graphically streamlined or slick as one might expect. In fact, they have more of a folksy, homespun aesthetic. What are you trying to convey with that look and feel? How do you think it affects the way people use them?

Not all my maps, or anybody else's, serve the same function. But many, especially the *mess maps*, are the intermediate results of different stages of work by different kinds of problem-solving groups. They are intended to help them gather and process information. For example, groups find it easier to fill in blobs and are intimidated by rectangles. In my experience, slickness and streamlined-

ness actually hinders the group. Effort in that direction would be costly and probably slow the process down. My work is primarily helping people and groups think—that is, doing analysis and synthesis—and visual language helps me and others do that. I think of visual language as operating at multiple levels, like any language.

I've fired graphic designers because they didn't pay sufficient attention to understanding the content of the diagram or map and hadn't involved themselves in the minute-by-minute process of working with the task forces. They were only interested in how it looked and what kind of exhibit or prize it could be submitted for, and hence were blind to what was going on in front of them in the group. In short, they weren't helpful to the group process—they were impediments. If I had one bit of advice to give neophyte graphics people it would be: get involved in the content.

What is involved in making one of these maps for a client? Let's look at the Complex Social Mess map you created for Multnomah County in Portland, Oregon. Your aim was to help a task force unfurl the complexities of its public mental health system.

Yes, the county commissioners knew they had a mess on their hands a couple of years ago in the delivery of public mental health. They appointed a task force headed by Elsa Porter, a former Assistant Secretary of Commerce, with 25 citizens—lawyers, doctors, caseworkers, policemen, patients' advocates—all trying to understand the same phenomenon. But they didn't have a way of putting the problems and causes together into a common mental map. Their (verbal) language is very linear. It's hard to retain all the relationships and causalities. In groups like this, they often start jumping to conclusions and solutions before they have a common understanding of the problems. Then the meeting ends—"see you next week or next month"—and they start over again, but three or four people who weren't there last time have to catch up. You get the usual committee chaos or stagnation.

How did you help?

Since they knew the territory, and I clearly didn't, they had to make the map. I sat down with a few task force members to learn what they were struggling with and the different organizational sectors they were working in. That's how we identified the blobs. We also determined the level of verbal language to use; here, informal language worked best.

Once you identified the sectors represented by the blobs, how did the task force provide more specific data needed to make the map?

We threw those sectors on a big sheet of paper, divided the task force into subgroups of five, and gave each one a list of sectors. I made a brief introduction and said, "we're going to make a common mental model here. You do that by writing the events and phenomena you believe cause things to happen. Don't worry; you're just putting what you know into these blobs."

When did you make the first map?

After they'd worked for a while, we took their big sheets of paper back to my office and put them in the computer to make a first draft, which we took back to the next meeting and worked on some more. After the third revision, we'd begun to determine what was really important to include and what wasn't.

Can you describe the final product?

It's a cross-boundary causality map that characterizes the situations, events and phenomena involved in this particular "social mess." These items were placed in sectors—the blobs—and connected by arrows that stand for causes or influences. The big yellow boxes are specific problems associated with each sector. Read closely in one sector, and you will see the words "case workers are leaving in droves." That is sufficient as a mental model; the task force doesn't need a table showing resignations over the last 18 months. The colored arrows trace multiple cross-boundary causality. The reason "case workers are leaving in droves" is partly because they have to fill out more paperwork, caused by new federal and state regulations (crossing two organizational boundaries) that have significantly changed county data-processing requirements (another boundary). But the county data-processing department couldn't create the new software because (crossing another boundary) a new Silicon Forest was evolving around Portland and paying higher salaries to programmers than the county could afford and Y2K was

also absorbing programmers. This is just one of 85 causality arrows that the task force chose to put on its mental map. They limited themselves to the most important ones. You don't want to describe the whole world.

Was the map a success?

It served two purposes. It facilitated the task force process by helping construct a common mental model. It gave the task force chair a tool to get all members involved and committed to the process. The map was actually used as the interim report to the County Commissioners, who were delighted with it; one said, "I see why we're hearing about problems." A mural-sized version was used in the public meeting where the report was presented. There was no written report.

It helped the supervisors and the task force to focus their thinking?

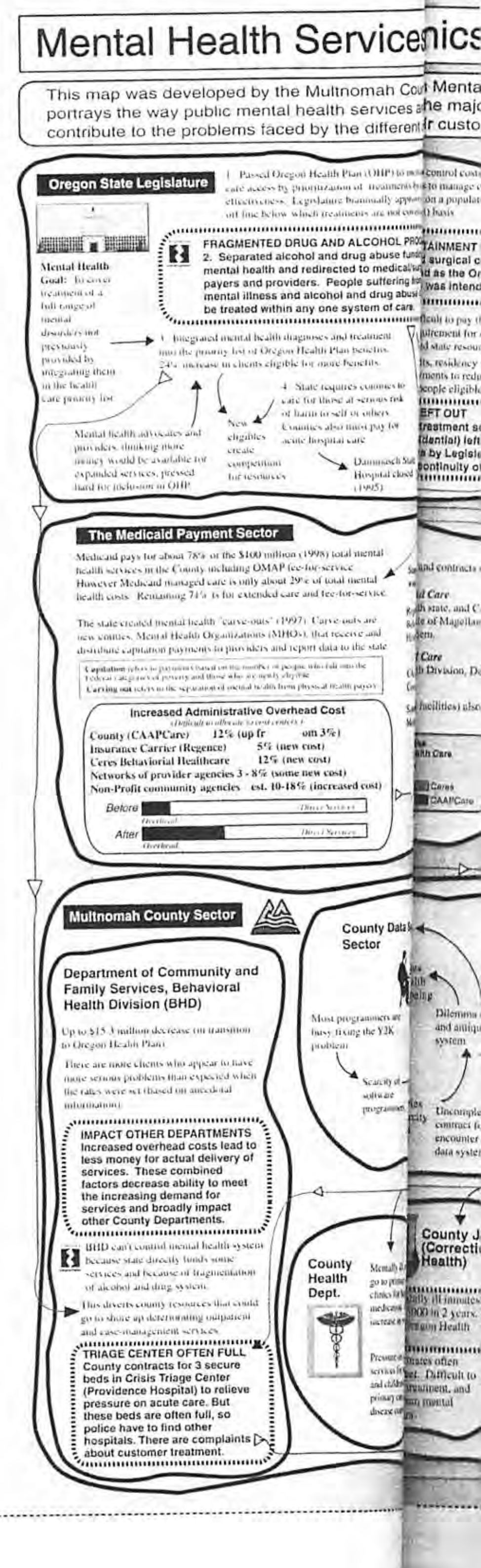
Yes, making the map helped them find out what their colleagues know and don't know, what they can rely on each other for, and whether one person's description of the world squares with another's. All that was happening in the process of making the map. It's social learning: how we learn together to solve, in this case, community problems.

Would you agree that first-time viewers of the Multnomah County map who were not involved in its creation might initially be confused by the various colored arrows and lack of obvious visual hierarchy?

As I said, the Multnomah Map was shown to the county supervisors. A very brief explanation was all they needed to appreciate it and assign the task force the further job of making recommendations for changes. The map served its purpose. The lack of obvious visual hierarchy is intentional; it conveys the feeling of a social mess.

Making maps of so many territories—from public policy dilemmas to debates about artificial intelligence—must require you to be an intellectual jack-of-all trades.

Human beings have bureaucratic impulses to draw boundaries and defend our territories. Of course, you can see why disciplines exist, for digging into very special questions. But all big real-world problems are interdisciplinary.



2004
The
Human Cognome
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To Think Bigger Thoughts

Why the Human Cognome Project Requires Visual Language Tools to Address Social Messes

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ABSTRACT: The need and use of visual languages in complex situations is outlined.

KEYWORDS: Human Cognome Project; cognome; visual language; social messes; communicating complexity; knowledge maps; knowledge mapping

SOCIAL MESSES—THE NEED TO THINK BIG THOUGHTS

Interconnectedness

Think about our socio-technical problems. Start anywhere—accelerating U.S. medical costs; the war in Afghanistan ; the drug war. The drug war, for example, cannot be thought about without taking into account some of the most powerful lobbies in the country, the prison guards and the private prison industry. Nor can the drug war be well understood without involving its connection with the civil war in Columbia (the largest producer of cocaine) or the nation building in Afghanistan (the largest producer of heroin). And these wars must be set against the backdrop of the huge international arms trade. Nor can the drug war be comprehensively analyzed without incorporating influences from the big pharmaceutical companies and the rapid increase in the use of prescription drugs (the largest increase in medical expenses). And pharmaceuticals, of course cannot be considered without a recognition of their embeddedness in the U.S. medical system, which does not provide health in-

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surance to cover 40 million citizens. I will stop drawing the points of interconnectedness here, but of course I could go on. Substantially all of our problems can be shown to be significantly interconnected with each other.

Social Messes

They've been called "wicked problems" (by Horst Rittle) and "ill-structured problems" (by Ian Mitroff), but I call them "social messes" (after Russell Ackoff, who simply refers to them as "messes"). What they are ***not*** is merely "problems." Problems have solutions. Social messes do not have straightforward "solutions."

The Definition of Social Messes

Social messes are more complicated and complex than textbook problems. They are

- ambiguous, containing considerable uncertainty, even as to what the conditions and facts are, let alone what the appropriate actions might be
- are bounded by great constraints and are tightly interconnected, economically, socially, politically, technologically;
- are seen differently from different points of views and worldviews;
- contain many value conflicts; and
- are often a-logical or illogical.

And there is no way of understanding one social mess without considering its deep involvement with a whole set of other problems.

More Examples of Social Messes

Our socio-technical systems are magnifying these social messes as well as providing occasional amelioration. But I am willing to predict that more wicked problems are on the way: genetically modified food, nanotechnology, biotechnology, the release of 80,000 chemicals untested for toxicity into the environment, nuclear waste disposal, bioterrorism, and the international struggle of worldviews, religions and ideologies. We have no shortage of social messes.

What are Big Thoughts

How do we get our minds around these messes? Most of us must admit that for many such problems we rely on the OpEd pieces of the newspaper for

guidance. But that's not enough. We need to be able to think about these messes with bigger thoughts.

And what are the characteristics of bigger thoughts? They are: more comprehensive, more complex, cover a longer time scale, and require more viewpoints than other problems. It is very easy to announce big thoughts. Unfortunately, our leaders and politicians name them all the time. But it is very difficult to get our minds deeply into them.

HUMAN COGNOME PROJECT

The Project

At the first National Science Foundation Workshop on Converging Technologies, I suggested that we set our vision on a century-long project to understand the "Human Cognome."[a] I thought that it might provide an umbrella concept for a cluster of research programs to begin to bring more science to bear on social messes and human vulnerability.

One Component: Cognitive Prostheses for Human Limitations

One major area for the Human Cognome Project to address is prostheses for human cognitive vulnerabilities. I suggested that cognitive psychology and the social sciences in general have identified a myriad of human shortcomings. To mention only a few such limitations: in perception we are easily distracted. Our memories are notoriously selective and defective. Social influences produce groupthink. Our capacity for conflict and violence is enormous. Our thinking categories are often skewed and our heuristic judgment about risks is distorted. We make decisions from simplistic models and think we are rational. We can learn only so fast. Emotions cloud our judgments. We have often let short-term gain outweigh longer-term benefits for society. Our individual disciplines have been quite systematic in discovering these limitations, but they have not comprehensively focused on overcoming or ameliorating them. I suggested that a major, focused effort in the Human Cognome Project could help us systematically build cognitive prostheses (tools, systems, concepts, training courses) to overcome or a least diminish the difficul-

[a]I first made the suggestion that we launch a Human Cognome Project at the Workshop on Converging Technology (NBIC) for Improving Human Performance sponsored by the National Science Foundation, the National Science and Technology Council, December 3–4, 2001. It was taken up by the workshop and first appeared in print in the NSF draft of 2/4/02, "Reports of the Five Breakout Panels." See Overview section of the prepublication draft of the full report at <wtec.org/ConvergingTechnologies/Report/NBIC_pre_publication.pdf>

ties these human vulnerabilities present in critical situations and social messes.

Visual Language to Manage Complexity

I believe that visual language (defined as the tight integration of words and visual elements) can serve as one major initial component of this project.[b] One of the ways to think of visual language is that it provides a prosthesis for some of the limitations of human thought. We humans are severely limited in working memory (only about 4 to 7 chunks at a time), but we are exceedingly good at scanning our immediate environment and forming patterns. Providing systematically organized, wall-size, visual language murals provides an environment for rapid scanning. Currently, such murals may have a thousand visual and verbal chunks of information. Using them, we substitute our ability to scan, focus in on detail, and find patterns for our ability to hold in working memory more than 4 to 7 chunks of information. Levels of detail can be switched rapidly by display management software. Visual language, thus, is an example of a cognitive prosthesis for comprehending the immense complexity of social messes. A broadscale approach to aiding the management of and communication about complexity in science and technology would be to focus support systematically on the development of visual language. It has a new syntax and a new semantics. This language is the foundation for the knowledge-mapping tools we are building for complex, shared mental models. It is helping us get our arms around problems and social messes.

HOW TO REPRESENT BIG THOUGHTS: VISUAL LANGUAGE

Our "Knowledge-Mapping" Approach

Our project at Stanford University has been designing and developing highly visual "cognitive maps" that facilitate the management and navigation through major public policy issues. These maps have benefits for policy analysts and decision-makers similar to those of geographic maps. They provide patterned abstractions of policy landscapes that permit the decision-makers and their advisors to consider which roads to take within the wider policy context. Like the hundreds of different projections of maps (e.g., polar or Mercator), they provide different ways of viewing issues and their backgrounds. They enable policy makers to drill down to the appropriate level of detail. In short, they provide an invaluable information management tool. Knowledge mapping has grown up as a result of the complexity of modern

[b]See Horn (1998).

life, and the capacity of the computer and new printers to help us create the maps.

On Mapping Theory and Practice

Our project has been developing prototypes of several kinds of visual cognitive maps. These maps are intended both to give a broad “helicopter” view of the territory as well as the ability to drill down to present relevant detail. Among the dozen or more of these types are:

- Cross-boundary causality and dynamics maps;
- Strategy maps;
- Scenario maps;
- Argumentation maps;
- Stakeholder goals, values, and pressures maps;
- Agreement templates; and
- Unknown territory maps

VISUAL LANGUAGE PROSTHESES AND THE HUMAN COGNOME PROJECT

Social messes are the subject matter of most public policy discussions. How can knowledge maps improve the discussions?

Very preliminary evaluations show that knowledge maps can contribute significantly to better knowledge management in complex policy discussion and decisions. They:

- show the logical and visual structure of the emerging arguments, viewpoints, empirical data, scenarios, trends, policy options (making communication more effective) and help keep the big picture from being obscured by the details;
- enable presuppositions to surface and be carried along with the debate or made a subject of the debate (enabling a richer discourse to take place without getting off track);
- allow more rapid analysis of the subject matter by committees and policy makers;
- help structure the flow of complex discussions (so that meetings are more productive and less time consuming), enabling rapid integration of diverse points of view;

- increase an appreciation for the complexity of the issues the group is addressing, permitting faster learning by experts and the general public;
- are visually appealing, colorful, and incorporate useful metaphors and images that encapsulate values and attitudes;
- enable participants who have missed meetings to catch up quickly;
- increase the chance of participants talking to each other, not past each other, bringing faster consensus in meetings; and
- help participants to keep working on the problems using the Web while separated by geographical distance.

CONCLUSION

I am convinced that the knowledge maps I've described can make a substantial contribution to a worrying condition of present day America—the fact that more and more people feel left out of democratic public debate to the point of giving up on it. Too many people lack the ability to follow what are often highly arcane and complex discussions. The life of our republic would be very different if, for the next generation, some foundations use the knowledge map methodology to make informed deliberation available to all Americans.

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FIGURE 1. A knowledge map about knowledge maps.

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The Turing Test

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Chapter #2

THE TURING TEST

Mapping and Navigating the Debate

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Abstract: Please add.

Key words: Please add.

1. BACKGROUND TO THE DEBATE

The Turing debate as to whether computers will ever be able to think, is one of the great philosophical debates of recent times. It focuses on what it means to be a human being. It lies at the foundation of cognitive science. It has great practical consequences to society and what our communities shall become (Kurzweil, 1999, Moravec 1999). The Turing debate is — as yet — unresolved.

The debate was initiated by Alan Turing in his article in *Mind* (Turing, 1950). Turing said, "I believe that at the end of the century [i.e. two years ago, as this chapter is written] ... one will be able to speak of machines thinking without expecting to be contradicted." Turing's article has unleashed five decades of debate about the many aspects of this proposition. Over 800 major "moves" in the argument later, we are still debating the subject. I say 800 major moves in the argument because that is the number we came up with after diagramming the important claims, rebuttals, and counterrebuttals of this argument.

2. THE PROBLEM OF COMPREHENDING A LARGE DEBATE

A debate this large and sprawling, carried on by over 400 scholars, researchers, and scientists world-wide from at least 10 academic disciplines is difficult for the human mind to comprehend. It is a gigantic knowledge management problem. But, over the centuries humans have created a whole visual language of large diagrams and maps to help us see the structure, organization, and dynamics of complex objects of study (Horn, 1998b, Chapter 2). When we must master the complex intricacies of debates such as those concerned with Turing's claim, we must have knowledge maps to help us navigate over the landscape of these arguments. (Horn, 2001) We need to be able to individuate the major claims from the oceans of prose that surround them. We need to isolate the principal data, experiences, or other grounds that support the arguments. Above all, we need to be able to know if the claims offered by each protagonist have been rebutted, perhaps utterly destroyed, by subsequent moves in the debate. We need to know who these protagonists are and from what worldview they are presenting their arguments. And all this needs to have some kind of graphical structure — some map-like presentation — so that we can scan and recognize areas of investigation as easily as using a roadmap. We need to take advantage of the capacity of visual tools to articulate the important relationships in the debate in ways that prose simply can not do.

If we don't have a map, our debates will become increasingly lost in detours and we are left spinning our wheels in muddy ditches. Our journey along the road of philosophy will be slow and frustrating. The foundations of the new cognitive science will be shaky. Our view of our technology future will be clouded.

3. OUR APPROACH: ARGUMENTATION MAPPING

Recently our team published an argumentation mapping approach to the Turing debate (Horn, et. al. 1998a). This set of maps is part of a larger series that is intended to create visual navigational tools for intellectual history. (Horn, 2000a, b) The "maps" are large diagrams, the core of which connects claims, rebuttals, and counterrebuttals together so that a person unfamiliar with the debates has a convenient way of seeing the structure of the debates as well as the detailed arguments. Figure 1 presents an example of one of 7 argumentation maps in the series about the Turing Test debates discussed in this book. Together, the seven maps (each of them 3 x 4 feet in size) provide

a complete framework and context for the Turing Test debates. Figures 3 – 9 provide close-up views of the details of the mapping of arguments taken from the maps.

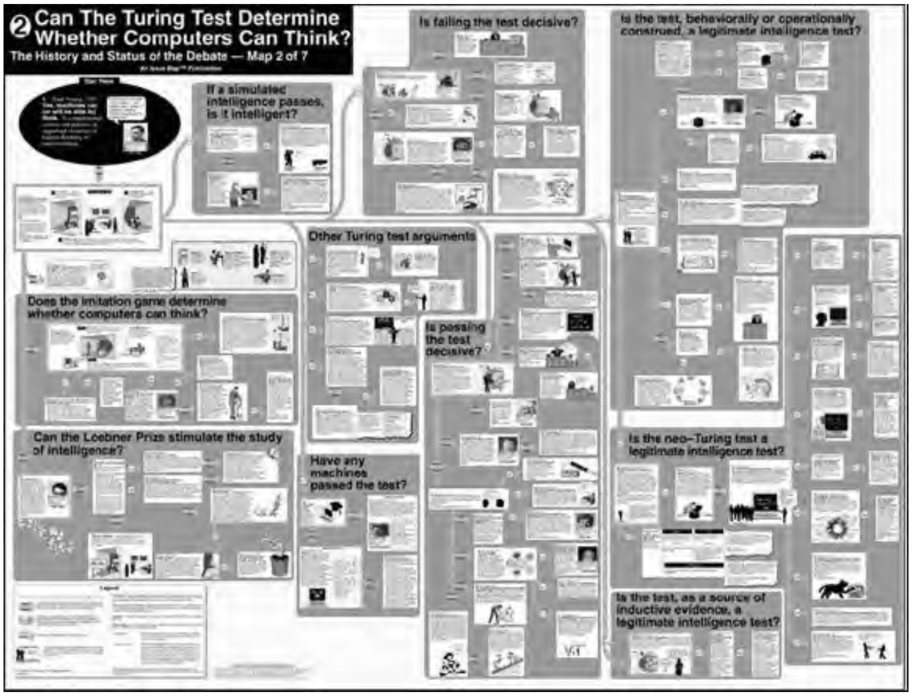

Figure #1. Can the Turing Test determine whether computers can think?

3.1 Sub-arguments show major "issue areas" of the debates

We divided—analytically and visually—the debates into some 70 subarguments, listed in Figure 2. Each provided an easily recognizable region of the maps.

Fig. 2 The subarguments of the basic question "Can Computers Think?

Over 70 questions on specific issues are addressed on the 7 Maps.
The argumentation maps summarize the following issues

Map 1: Can computers think?
Can computers have free will?
Can computers have emotions?
Can computers be creative?
Can computers understand arithmetic?
Can computers draw analogies?
Can computers be persons?
Is the brain a computer?
Can computers reason scientifically?
Are computers inherently disabled?
Should we pretend that computers will never be able to think?
Does God prohibit computers from thinking?

Map 2: Can the Turing test determine whether computers can think?
Is failing the test decisive?
Is passing the test decisive?
If a simulated intelligence passes, is it intelligent?
Have any machines passed the test?
Is the test, behaviorally or operationally construed, a legitimate intelligence test?
Is the test, as a source of inductive evidence, a legitimate intelligence test?
Is the neo-Turing test a legitimate intelligence test?
Does the imitation game determine whether computers can think?
Can the Loebner Prize stimulate the study of intelligence?
Other Turing test arguments

Map 3: Can physical symbol systems think?
Does thinking require a body?
Is the relation between hardware and software similar to that between human brains and minds?
Can physical symbol systems learn as humans do?
Can the elements of thinking be represented in discrete symbolic form?
Can symbolic representations account for human thinking?
Does the situated action paradigm show that computers can't think?
Can physical symbol systems think dialectically?
Can a symbolic knowledge base represent human understanding?
Do humans use rules as physical symbol systems do?
Does mental processing rely on heuristic search?
Do physical symbol systems play chess as humans do?
Other physical symbol systems arguments

Figure 2. The subarguments of the basic question "Can Computers Think?
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Map 4: Can Chinese Rooms think?
Do humans, unlike computers, have intrinsic intentionality?
Is biological naturalism valid?
Can computers cross the syntax–semantics barrier?
Can learning machines cross the syntax–semantics barrier?
Can brain simulators think?
Can robots think?
Can a combination robot/brain simulator think?
Can the Chinese Room, considered as a total system, think?
Do Chinese Rooms instantiate programs?
Can an internalized Chinese Room think?
Can translations occur between the internalized Chinese Room and the internalizing English speaker?
Can computers have the right causal powers?
Is strong AI a valid category?
Other Chinese Room arguments

Map 5, Part 1: Can connectionist networks think?
Are connectionist networks like human neural networks?
Do connectionist networks follow rules?
Are connectionist networks vulnerable to the arguments against physical symbol systems?
Does the subsymbolic paradigm offer a valid account of connectionism?
Can connectionist networks exhibit systematicity?
Other connectionist arguments

Map 5, Part 2: Can computers think in images?
Can images be realistically represented in computer arrays?
Can computers represent the analogue properties of images?
Can computers recognize Gestalts?
Are images less fundamental than propositions?
Is image psychology a valid approach to mental processing?
Are images quasi-pictorial representations?
Other imagery arguments

Map 6: Do computers have to be conscious to think?
Can computers be conscious?
Is consciousness necessary for thought?
Is the consciousness requirement solipsistic?
Can higher-order representations produce consciousness?
Can functional states generate consciousness?
Does physicalism show that computers can be conscious?
Does the connection principle show that consciousness is necessary for thought?

Map 7: Are thinking computers mathematically possible?
Is mechanistic philosophy valid?
Does Gödel's theorem show that machines can't think?
Does Gödel's theorem show that machines can't be conscious?
Do mathematical theorems like Gödel's show that computers are intrinsically limited?
Does Gödel's theorem show that mathematical insight is non-algorithmic?
Can automata think?
Is the Lucas argument dialectical?
Can improved machines beat the Lucas argument?
Is the use of consistency in the Lucas argument problematic?
Other Lucas arguments

Figure 2. The subarguments of the basic question "Can Computers Think?

Figure #2. The subarguments of the basic question, "Can computers think?"

4. PARTS OF THE DEBATE COVERED IN THIS CHAPTER

Our maps provide a way of looking at the debate as it stood in late 1997 when our final prepublication work was done. As with any geographical map, the territory changes over time. Thus our maps may be slightly behind the times, although we believe that the major topography of the debates remains.

The discussion in this chapter will cover the following topics from Map 2:

- Is the imitation game adequate?
- Is failing the Turing Test decisive?
- Is passing the Turing Test decisive?
- Have any machines passed the Turing Test?

5. QUESTIONS NOT COVERED IN THIS CHAPTER

Other topics on Map 2 cannot be covered in this chapter because of space limitations:

- Is the Turing Test, behaviorally or operationally construed, a legitimate intelligence test?
- Is the Turing Test, as a source of inductive evidence, a legitimate intelligence test?
- Is the neo-Turing Test a legitimate intelligence test?
- Can the Loebner Prize stimulate the study of intelligence?

6. WIDER DEBATES COVERED IN OTHER MAPS

Because of the limited parameters of this book, we also cannot review herein the wider debates that Turing's claim has provoked. These revolve around the von Neuman (Map 3) and Connectionist (Map 5) computer architectures, the clashes about consciousness and computing (Map 6), and the brilliant debate about whether, at bottom, thought is somehow visual and, hence, in order to think machines must be visual (Map 5). This chapter also cannot cover in detail the extraordinary 10-year combat about the Chinese Room (Map 4) that asks if syntax alone can produce semantics. Each of these sub-debates average close to 100 major "moves" each and their own history and structure. The reader who is interested in such sub-questions as those concerned with the Gödel or Penrose debates, the Chinese Room arguments, or the Heidiggerian perspectives advanced by Dreyfus will have to consult Maps 7, 4, and 3 respectively. No doubt many of these issues will be debated in this book. Whether the authors address the previous major moves in the argument can be examined in the seven maps. These wider issues, of course, contradict Turing's denial that people might achieve wide agreement about how thinking might be assessed by the use of his test.

7. IMPORTANT POSSIBILITIES THAT ARGUMENTATION MAPPING PROVIDES

This chapter will thus provide an overview of the structure of a central part of the argument and, in addition, provide a way for the reader of this book to begin to determine several important questions:

- What *new* lines of argument have developed since our series of maps was published and how do these new debates fit into the overall structure of the debate so far?

- What lines of argument have been *extended* by new rebuttals, counterrebuttals, or evidence? (The argumentation maps, in addition to displaying the intellectual history of the sidebars, provide an easy way of seeing where the debates have stopped or paused. You can read the last rebuttal in each thread of the argument on the right-hand side of each thread.)
- What new ways of *framing* the arguments have been offered since then?
- What claims or rebuttals have *not* been replied to? (And what can we infer about *that*?)

8. UNDERSTANDING THE TURING TEST ITSELF

Let us now investigate in detail the structure of the arguments by examining some of the core questions. To do this, one must first understand the test itself. Turing starts by envisioning a guessing game played by a woman and a man as described in Figure 3. In our argumentation mapping approach, if something can be explained by a combination of words and pictures better than by words alone, we provide a visual illustration.

This imitation game sets up the framework for the test. But Turing is interested in computers, so he replaces one of these humans with a computer and makes his claim that this test will provide an operational definition of "thinking." (See Fig. 4.)

This, then, is the central situation about which so much has been debated and about which this book revolves. Because there are so many interpretations of the test based on so many worldviews, the debates have gone off in many directions. It can be argued that the test will never be conclusive because test results always have to be interpreted and interpretations always are subject to further debate. (This could be argued, but, in fact, is not an argument that appears on our argumentation maps, because, at the time of publication, we did not find it argued explicitly by any of the protagonists!)

8.1 Does the imitation game help determine whether computers can think?

The first debate is on the structure of the debate itself, on the imitation game. (See Fig. 5.)

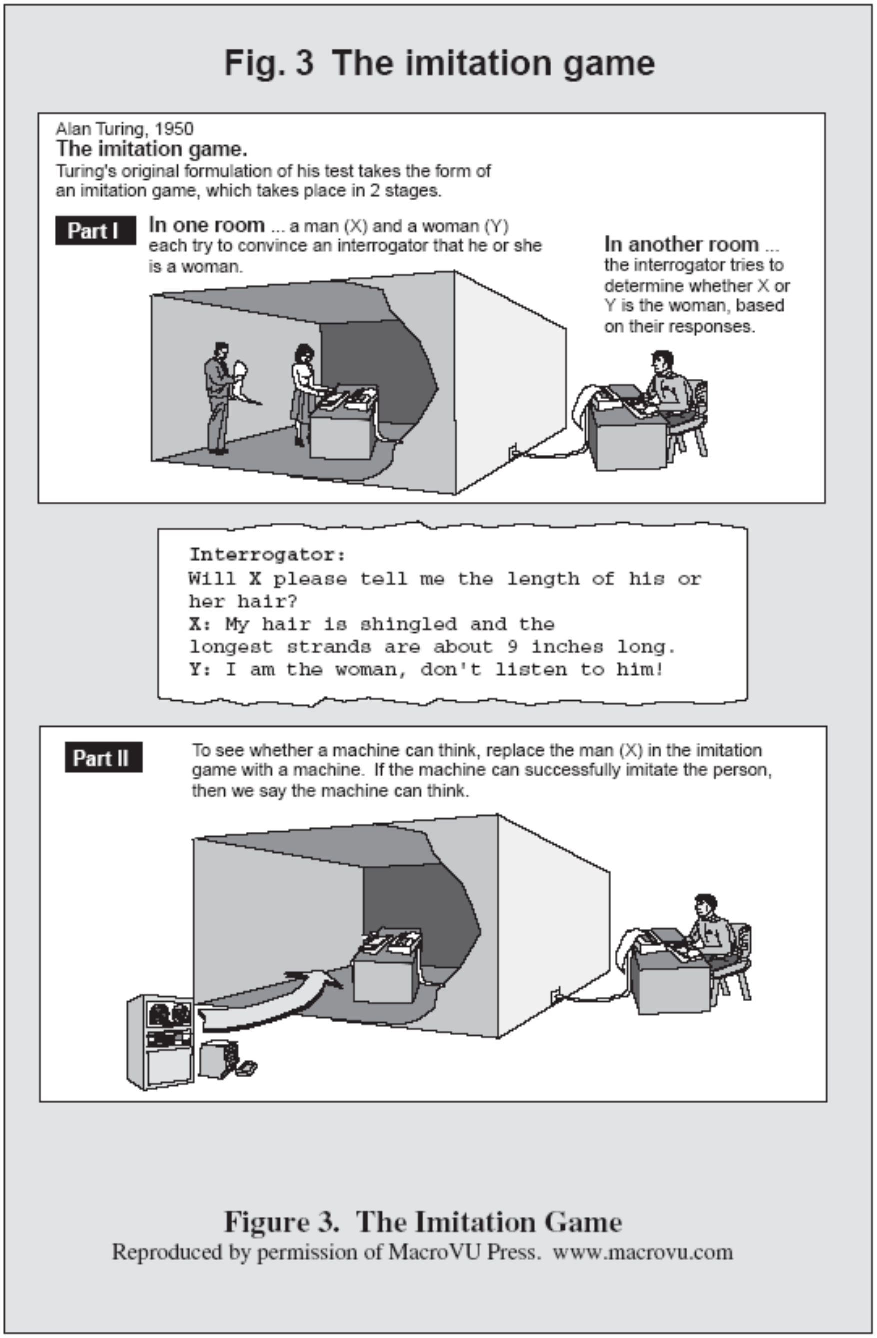

Figure #3. The imitation game

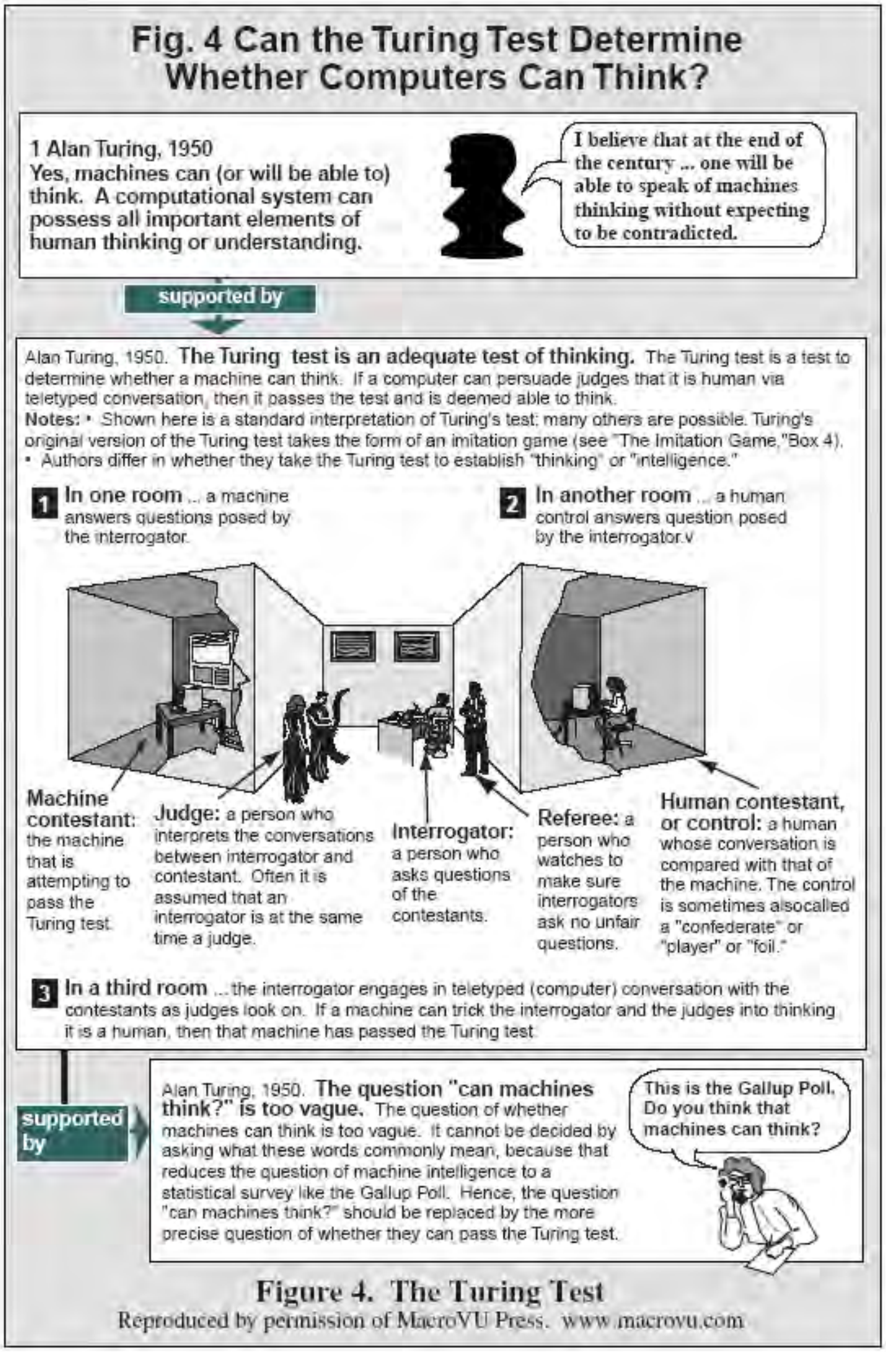

Figure #4. Can the Turing Test determine whether computers can think?

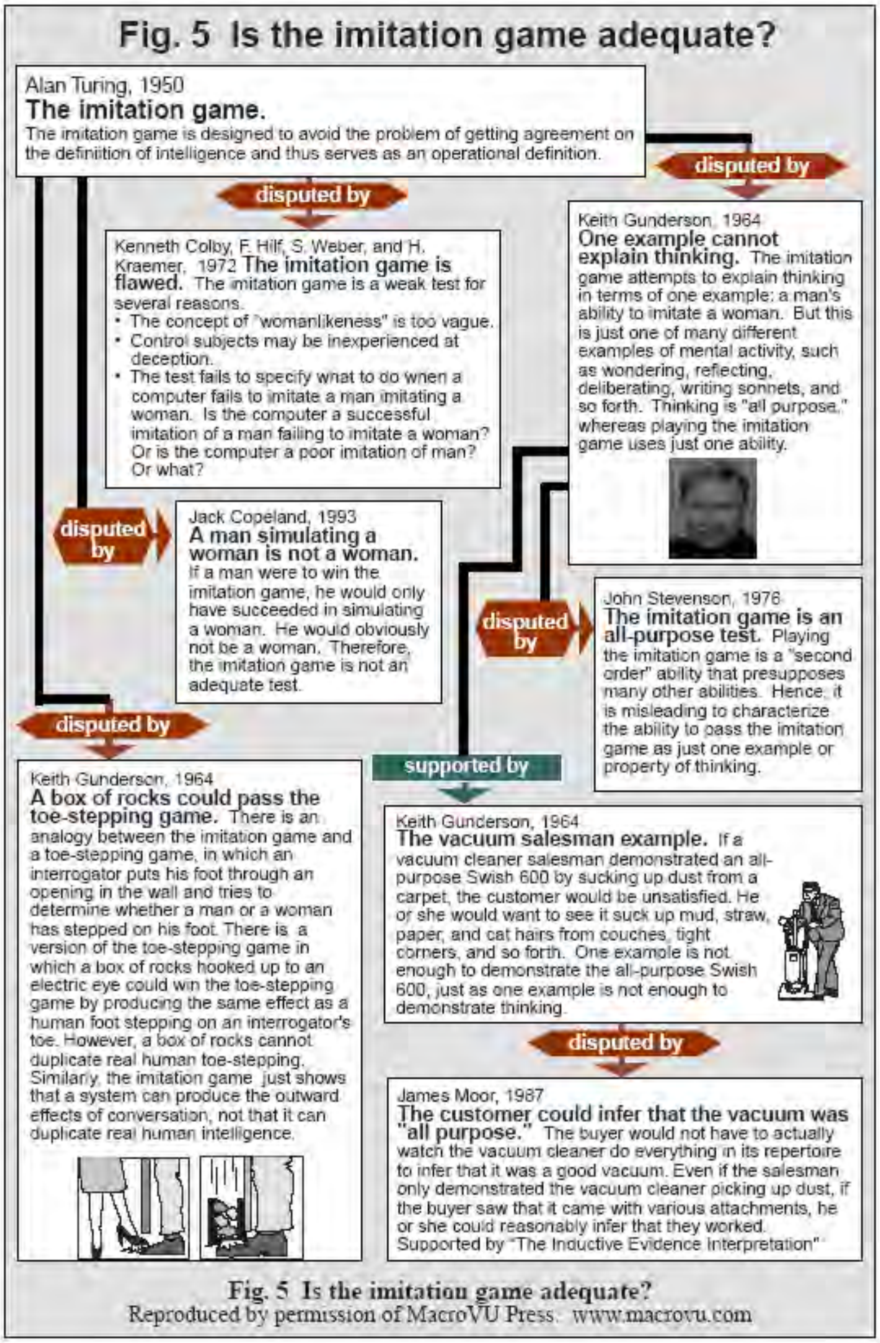

Figure #5. Is the imitation game adequate?

How are we to assess this path of the debate?

8.1.1 Assessment of the debate so far.

The map tells us immediately that there are provocative and unanswered critiques. How? One can read the unanswered arguments from the end of the diagram paths. Why are they unanswered? Perhaps because others have evaluated the claims as unimportant enough not to waste time on. After all, several of the claims are quite old. Or perhaps they have simply been missed because they appear in a book or article now out of print. Or, perhaps, someone has answered these claims and our research did not find their rebuttals. Whatever the case, one of the benefits of the mapping approach is to identify unanswered rebuttals. They offer the opportunity for entry into the debate at very precise points. And they point to potentially key aspects of the debate: If these claims go unanswered, is the attempt to base the computer version of the imitation game also ungrounded?

8.2 After Turing's claim, how has the debate proceeded?

The two most important questions about the adequacy of the Turing Test are: "Is failing the test decisive?" And "Is passing the test decisive?" If the test is not adequate in these respects, the rest of the debate about the test is limited. In the remainder of this chapter I will present some sections of our maps on the subsequent 50 years of the debate.

8.3 Is failing the test decisive?

The answer to this question is important. It is directed at the adequacy of the test itself. Ned Block's 1981 claim is that failing the test is *not* decisive. It is possible to fail the Turing Test for intelligence, he says, and still be an intelligent being. This has provoked a series of arguments showed in Figure 6.

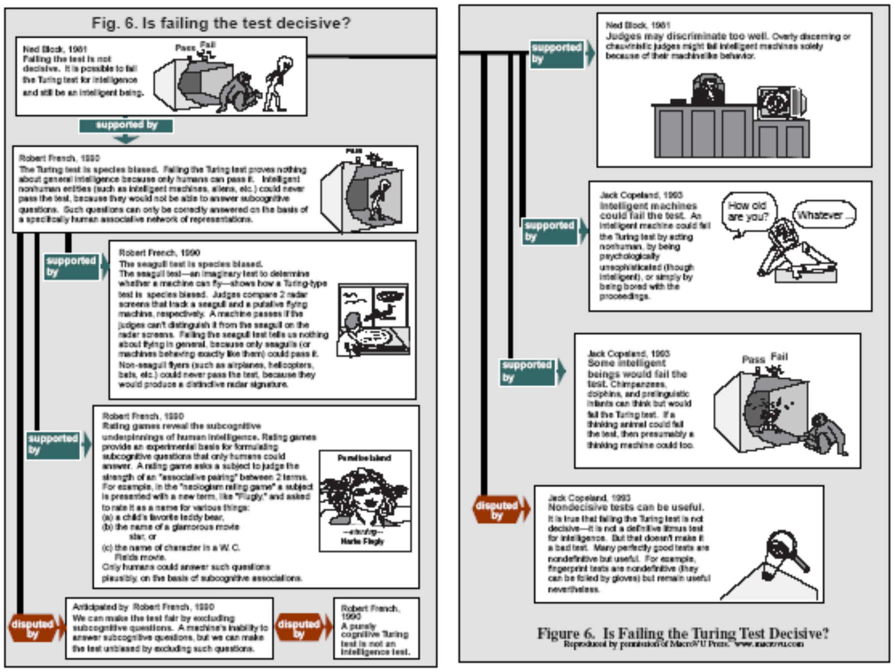

Figure #6. Is failing the test decisive?

8.3.1 Assessment of the debate so far.

It would seem that the three claims offered by Ned Block and Jack Copeland would have been answered. Perhaps they have. But it is surprising that we did not find these rebuttals in our extensive search of the literature. Block claims judges may discriminate too well. Overly discerning or chauvinistic judges might fail intelligent machines solely because of their machine-like behavior. Copeland points out that intelligent machines could fail the by acting nonhuman, by being psychologically unsophisticated (though intelligent), or simply by being bored with the proceedings. Copeland also says chimpanzees, dolphins, and prelinguistic infants can think, but would fail the Turing Test . If a thinking animal could fail the test, then presumably a thinking machine could too.

There are some qualifications that could answer these objections. In the next rounds of the debate, who will make them? Will they hold up? This shows how argumentation maps are extensible in quite a straightforward fashion. They afford the community of those interested in the debates a framework for joining in and contributing. We are currently working on software that would permit such collaborative argumentation on the web.

When this facility is available, participants will be able to offer additions to the maps as well as get an up-to-date status of the debates.

8.4 Is passing the test decisive?

This question is the obverse of the previous question. Block starts the debate asserting that passing the test is not decisive. Even if a computer were to pass the Turing Test, he says, this would not justify the conclusion that it was thinking intelligently. This side of the debate has produced a very lively and extensive exchange. (See Fig. 7.)

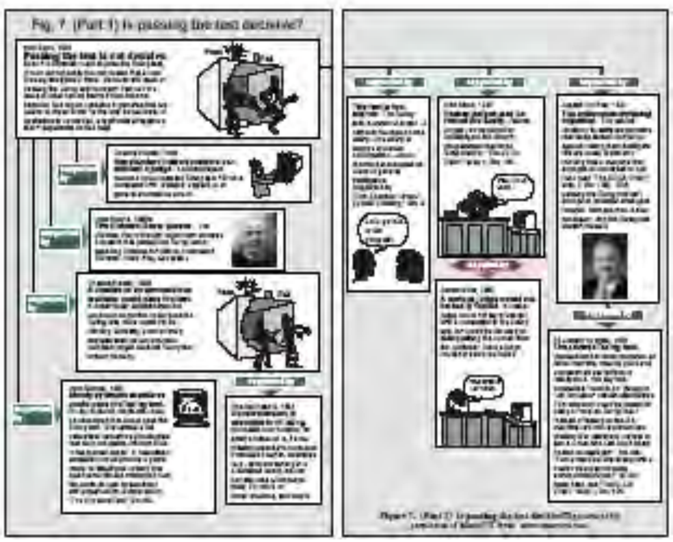

Figure #7.1. (Part 1) Is passing the test decisive?

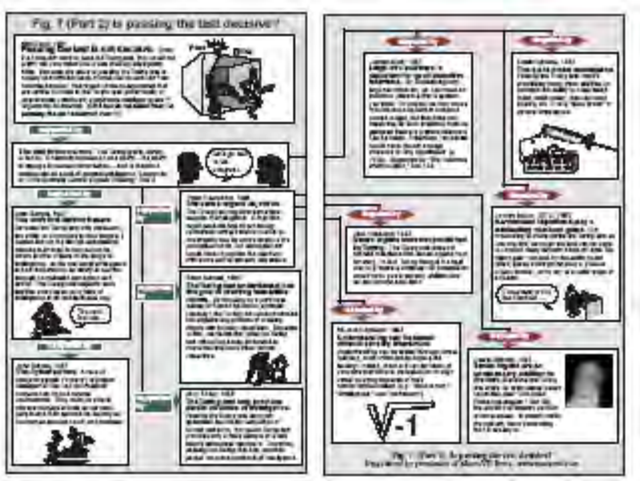

Figure #7.2. (Part 2) Is passing the test decisive?

8.4.1 Assessment of the debate so far.

Most of the debate so far has focused on whether the test is too narrow and proponents of the test have rallied to its defense. Note that here is where the arguments summarized on Map 2 are linked to many other parts of the *Can Computers Think?* series. For example, here is the link to John Searle's famous Chinese Room argument. (See Fig. 8.)

8.4.2 Assessment of the debate so far.

The Chinese Room argument itself produced such an extensive and prolonged debate that we have devoted one entire map (over 100 moves) to that debate (Map 4). Participants on neither side of the Chinese Room debate concede that the other side has made decisive arguments. What are we to think about that? Why is the debate stalled? Is something missing? Is it only that protagonists will stick by their assumptions?

8.5 Have any machines passed the test?

It is apparent that Turing's Test has not been passed by any machines yet. But we have provided a framework for future debate about it. The two software programs presented on the map simply indicate how future moves in the debate will be treated. (See Fig. 9.) This issue area is where the tests conducted annually with real software will swell the debate.

Figure #8. The Chinese Room

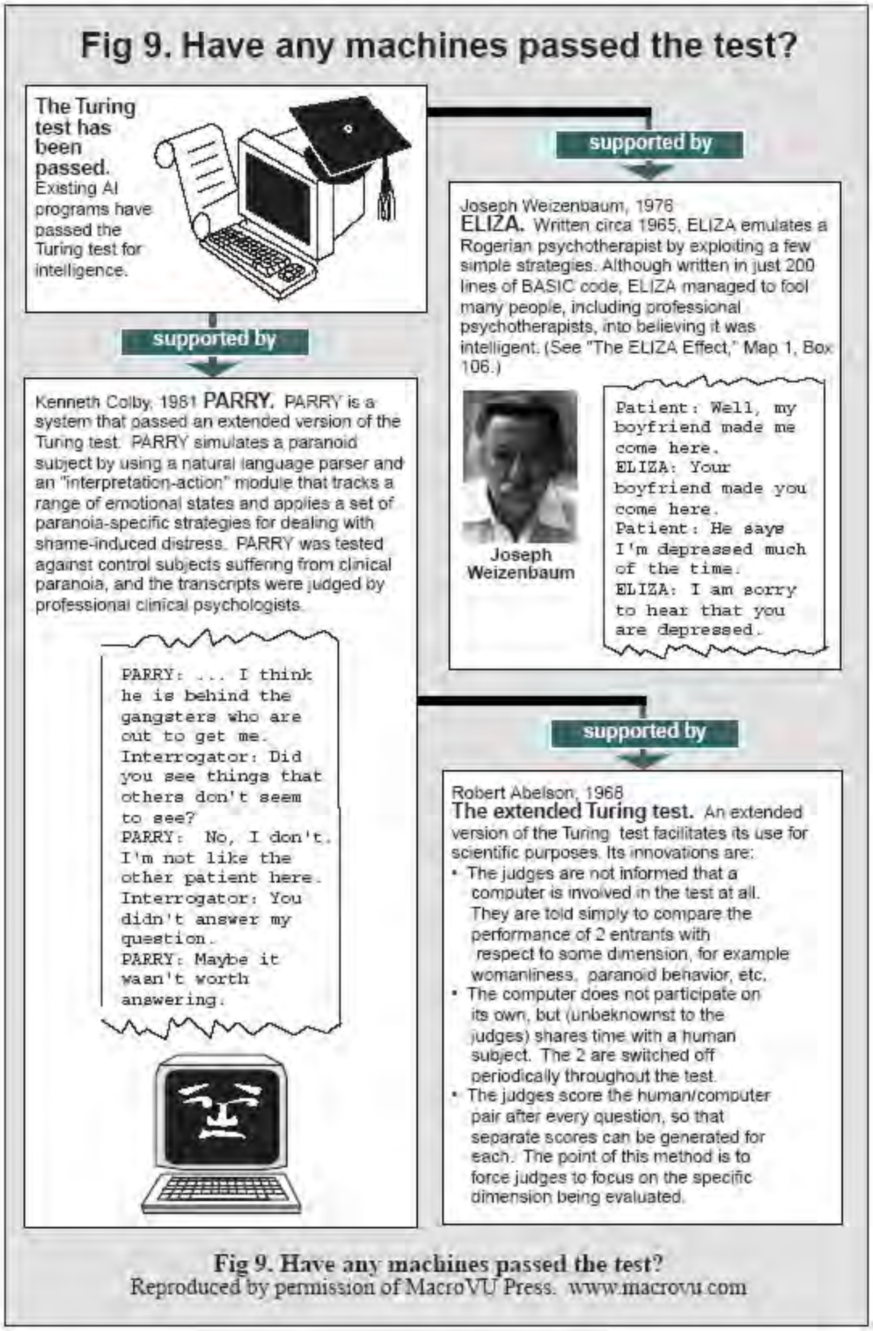

Figure #9. Have any machines passed the test?

8.5.1 Assessment of the debate so far.

One of the exciting aspects of following the Turing Test debates is Kurzweil's (1999) claim that supercomputers will reach the capacity of the human brain in 2010.

9. CONCLUSIONS

9.1 Benefits of argumentation maps

To sum up, the argumentation maps have a number of benefits for a debate as extensive as that about the Turing Test. Argumentation maps:

- Identify clearly the major supporting evidence for the claims and major attacks upon them in a way that makes easy comparison and evaluation of arguments.
- Enable participants to separate the claims and rebuttals from the process of evaluating (or giving weight to) them.
- Show at a glance the location of unanswered claims or rebuttals (making the discussion more sharply focused) and enable the discussion to grow (instead of starting over again from the beginning each time the group gets together or a new book is published).
- Provide a framework to enable the group of inquirers to go easily to deeper levels of detail to investigate their differences and agreements.
- Integrate arguments from all points of view and supporting data and can show the worldviews from which participants argue.

For this reason, we look forward to more progress in clarifying the issues and aiding us all to navigate the debate, and eventually, perhaps, a decisive conclusion to these debates.

NOTES

Our argumentation mapping project began in the mid-80s. The work I had done on the Information Mapping ® method of structured writing and analysis is a successful attempt to carefully delineate a taxonomy and a methodology for relatively stable subject matter. (Horn, 1989, 1992a , 1992b, 1993, 1995) Relatively stable subject matter is that which doesn't change much and about which there is little dispute. Information Mapping's method is widely used in industry and government for writing documentation, training, procedures and policies, and reports. Information Mapping is a registered trademark of Information Mapping, Inc. (See

www.informap.com.) The argumentation mapping extends these ideas to disputed discourse.

ACKNOWLEDGEMENTS

I want to salute and thank the members of my team — Jeff Yoshimi, Mark Deering, (of the University of California, Irvine) and Russ McBride (University of California, Berkeley — without whose dedicated effort and creative thought these maps would not be what they are today. I also want to thank the publishers, MacroVU, Inc. and the Lexington Institute, for their generous support of the *Can Computers Think?* Project.

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2019
The Future of Text

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https://archive.org/details/the-future-of-text-book/page/n3/mode/2up

Explanation, Reporting, Argumentation, Visual-Verbal and The Future of Text

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Structured Writing

Problem
In this era of overwhelming amount of complex information, to read new text we must be able to easily scan and skip what we already know. We must be able to see immediately the patterns and structure of patterns contained in the communication. Writers must be able to write documents parts of which will be not be read by all relevant readers. There are various ways of doing this. I present three that have an important future.

Partial solution: structured writing (aka Information Mapping®)
Structured writing is an integrated synthesis of tools and techniques for the analysis of complex subject matters (primarily explanation and reporting) and a group of standards and techniques for the management of large amounts of rapidly changing information. It includes procedures for planning, organizing, sequencing, and presenting communications.

My research has shown that for stable subject matters, *you can divide all the relevant sentences into 40 categories.* Some examples are: Analogy, Definition, Description, Diagram, Example, Non-example, Fact, Comment, Notation, Objectives, Principle, Purpose, Rule, etc. Some of the sentences stand by themselves in these categories (e.g. Definitions, Examples). Other sentences make sense as part of larger structures (e.g. Parts-Function Table, Diagrams).

Key features
Always writen in small chunks (also called blocks). Unlike many paragraphs, only one topic per chunk. Nothing extra. Chunks usually contain several sentences. *Label every chunk with an informative, relevant, short, bold-face title.* Standards available for organizing and sequencing larger documents. Diagrams and illustrations can be chunks. Use them.

Possible to cluster most of the 40 sentence types into seven categories: procedure, process, structure, concept, fact, classification, principle. Another 160 chunk-types available for Report Documents and Scientific and Technical Reports.

Hierarchy and other sequencing

For larger structure, you can use outlining or your favorite method of sequencing thought. Don't hide the outline from the reader. Many bold-face document structure subheads. Integrate your chunks into larger structure.

Advantages

• Precision modularity.
• Ease of scanning and skipping of irrelevant text.
• Ability to determine if completeness of subject is covered.
• Improves efficiency of analytic and learning processes.
• Has been applied to other discourse domains: e.g. science abstracts and reports and argument mapping.
• Greater ability to specify rule domains of components and rules for writing clearly.
• Improved decision making. Fewer errors. Sometimes improved creativity.

About 400,000 technical and business writers world-wide have been taught to write structured writing since 1969.

Visual Language

Visual-verbal integration

Text tightly integrated with visual elements, – shapes and images – is rapidly proliferating. I call this visual language and it specifically addresses the functionality question: "When working tightly together, what do words do best and what do visual elements do best?"

Diagrams are prototypical examples. The lines, arrows, and shapes represent relationships. The words represent either process or objects. Tightly and properly integrated, they provide the best representations for mental models and for many kinds of decision making. We can no longer pretend that text exists outside of any context, particularly visual-verbal context.

Images provide concreteness that words do not provide. Shapes provide structure, organization, connections, movement, and quantitative and qualitative relationships that are difficult to easily replicate in a purely textual document.

Linguistics

Various scholars have theoretical systems of the basic morphology primitives of visual language. They have also described visual-verbal syntax, levels, and topologies.

Semantic elements
The semantics of visual language combines elements from visual metaphors, diagrams, cartooning, engineering drawing, and incorporate space, and composition as well as perception and time. The semantics describes unique forms of disambiguation, labeling, chunking, clustering and distinct rhetorical devices. It is possible to distinguish between mere juxtaposition and visual-verbal integration.

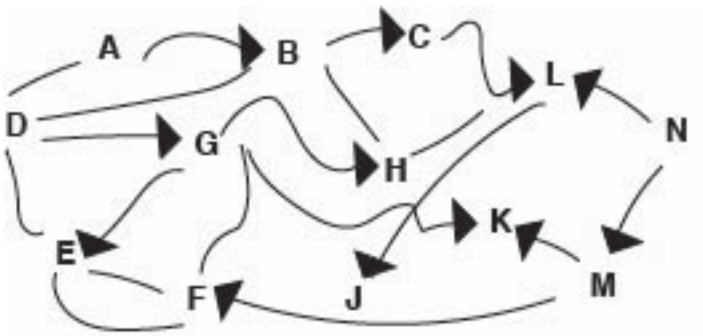
Functional semantics
Functional semantics provides the ability to:
• guide readers through a document more easily,
• focus reader's attention,
• organize overall page or screen design,
• show the context of concepts and models,
• provide a different level of lightness, humor, irony,
• increase impact and focus,
•show how to manipulate and operate decision options and systems.

It also permits:
• exploration of deeper connections and feelings,
• illuminates cross boundary issues,
• generally provides launching pad for more creativity.
• easier portrayal of multiple points of view and disagreements,
• facilitates cross-cultural communication and the understanding group process.

Thus visual-verbal language transcends the constraining effects of only using the alphabet.

The Advantages
Overall, this tight integration a visual-verbal elements enables:
• faster reading,
• easier scanning and browsing,
• more opportunities for the creative re-patterning of thoughts, and
• the careful tracing and rearrangement of complex relationships.

Exercise
For example, diagramming can provide the ability to quickly identify relationships that are difficult, if not almost impossible, to express in text by itself. Here is a simplified diagram.



KEY.   Arrows = causes. Lines = influences   Letters: Events

Your task: Write out in text *all* of the relationships shown in this diagram.

Question: Does your list identify all of the relationships?
Does it identify distance between events?
Does it identify all of the ambiguities of the influence lines?
How do you express the difference in distance between A-D and L-J?
How does express the wiggle in arrow G-K?

Argumentation Mapping

Disputed subject matter
In disagreement, it is possible to clarify much with various forms of argumentation mapping, a form of diagramming. Uses six categories for classifying your sentences into the diagrams: Grounds, Claims, Warrants, Backing, Qualifiers, Rebuttals.

The (Near?) Future

Predictions: Humanity will continue to build its systems of thinking with structured writing, argumentation mapping, and visual language.

Expect new words, new diagrams, an atlas of normalized diagrams, visual-verbal icons (vlicons) and information murals. These will provide us with further ability to both express ourselves more precisely and quickly, while portraying necessary complex contexts for communication.

References

For details of these ideas, my books and speeches:
Mapping Hypertext (Chapt. 3,7,8) –download PDF:
https://archive.org/details/mappinghypertext0000horn

Visual Language download PDF:
https://ia800202.us.archive.org/9/items/visuallanguagegl00horn/visuallanguagegl00horn.pdf
The Little Book Of Wicked Problems And Social Messes, download PDF:
http://www.bobhorn.us/assets/wicked_prob_book__bob_horn-v.8.1.pdf
What Kinds of Writing Have a Future? Speech prepared in connection with receiving Lifetime Achievement Award by the Association of Computing Machinery SIGDOC, October 22, 2001 (PDF)
https://web.stanford.edu/~rhorn/a/recent/spchWhat%20KindsOfWrtng.pdf

2022
Diagrams, Meta-Diagrams and Mega-Diagrams

A chapter “One Million Next Steps in Thought-Improvement” in Hegland, F.A.(2022)
The Future of Text, Vol. 2, 2022
https://archive.org/details/fot2_20211211/page/1/mode/2up

Diagrams, Meta-Diagrams and Mega-Diagrams

One Million Next Steps in Thought-Improvement

Chapter for the Future of Text, Vol. 2

Bob Horn

Here is how it started.
A friend sent me this quote from an introduction to a book:

"Therefore, it is suggested that novices first approach this text by going through it from beginning to end, reviewing only the color graphics and the legends for these graphics. Virtually everything covered in the text is also covered in the graphics and icons. Once having gone through all the color graphics in these chapters, it is recommended that the reader then go back ro the beginning of the book and read the entire text, reviewing the graphics at the same time. Finally, after the text has been read, the entire book can be rapidly reviewed merely by referring to the various color graphics."

The author says, "don't read the text first!"

My background
Having written a book *Visual Language: Global Communication for the 21st Century*, on the syntax, semantics, and pragmatics of tightly integrating words and visual elements, I was interested enough to buy the book.

It's a big book
644 pages

The visual language it contains
538 diagrams
62 Tables
Total: 600 diagrams and tables in 644 pages!

The Book. Stephen M. Stahl (2000) *Essential Psycho-pharmacology: Neuroscientific Basis and Practical Applications*. Cambridge University Press. (I used the 2d edition. It is now in its 7th edition)

Use. Text. Medical school.

Prerequisites. Psychology; chemistry; biology; medicine

I was amazed. I went around and asked some medical students at Stanford, "What do you do with your big texts? Like this textbook?"

They said (I'm summarizing): "Oh, we always read the graphics first. ***We never read the text***. There's too much to read in medical school. Every few weeks we've got a bunch of those 600 page books to cover. The diagrams are faster. You can see the structure of the models. The tables you can see the data. You don't have to search around in the text for them."

Is massive use of diagramming part of the future of text? Yes, I think so.

Why? Because we have to build written communication so that learners (and forgetters) can use it at maximum speed. All of us must be able to scan and skip what we already know. We must be able *instantly to see the structures* of the mental models we need to use.

Hypertext will not solve thought-improvement

We live in a world of information overload. Hypertext (without diagramming) will help somewhat, but will *not* solve the scanning/skipping problem. Even better hypertext that links "everything" important and relevant will, of course, be useful. But such better access is not nearly enough. (Horn, 1989)

A major problem is how do we continuously improve our thinking about the world around us.

How do we make sense of it?

Mental models.

How do we make sense of complicated models?

Diagrams.

My general conclusion is: We have to work on the thought-improvement problem. And integrated sets of diagrams and their meta-theory are immediate next steps.

One other thought-improvement idea. Eco-philosopher Timothy Morgan has addressed one of the limitations of our current thought-processes with his invention of the concept of "*hyperobjects*." Hyperobjects can be defined as huge phenomena whose concepts are so gigantic in time, space and other characteristics that we have increasing difficulty wrapping our minds around them, and hence, not easily making sense of them. Examples of hyperobjects: Morton mentions climate change and radioactivity. There is not enough space in this article to extensively describe and discuss his thoughts on this. Look him up (Morton 2013; no date)

Crisis in public discussion

We face challenges to our democracy in the public comprehension of the increasingly wicked problems and social messes we face. Again it is the understanding of complexity of the issues and the kinds of thought processes required that can make the most progress now.

Importance of diagrams to improving human performance

Two important series of psychological experiments have produced empirical results to support the conclusion that diagrams improve the efficiency and effectiveness of learning. The improvements vary in different experiments from 20 to 89 percent over conventionional presentation of prose (i.e. essay form of text) (Summarized in Sweller 1999, Mayer, 2001).

We can draw two conclusions: (1) using more and better diagrams could significantly improve learning and, thereby, human performance at many levels of schooling and subsequent professional work tasks, and (2) we need to create an advanced science and technology of diagramming because some diagram renderings of a mental model are better than others for learning, retention, search, and hyper-linking.

Meta-diagramming of diagrams

Are there types of diagrams? Yes, there is the beginnings of a field here, with initial explorations of taxonomies and further attempts to make software that enables the creation of different types of problems that result in creation of different kinds of diagrams. I proposed one simple set of meta-categories in my book *Visual Language* (Horn, 1998).

Proposal: Launch a mega-diagramming project to diagram several complete subject matters

We need a one-million, integrated-diagrams project for that!

Given the computational capabilities that we have now, it is possible to diagram several complete and quite different subject matters, fields, or disciplines of science and the humanities. Does the internet already contain all of the diagrams of one or more subject matters or discipline? Probably not all, but a considerable amount. It is highly likely that with artificial intelligence we will find and create the meta-frameworks for much of what is not currently available.

The mega-diagramming project will not be the "solution" to all our current challenges of thought-improvement. But it is clearly one of the next steps. And we don't know what opportunities the accomplishment of such a project would produce. Just one example might be an answer to the question: What are the elements text that do not "fit" into diagrams of any kind? Another example: the massively diagrammed field of knowledge would permit the hyper-linking of a fully diagrammed discipline of science. This would permit a new way of *seeing* it. New ways of seeing enable new insights, new identification of problems, new analogs between disciplines, and new ways of redesigning.

Next: Leaders needed

Who wants to lead such an important project? What organization will fund it? I have suggested elsewhere that it could form the foundation for metaphorically sequencing the

human cognome (2002b). A mega-diagramming project is one doorway to that objective.

Notes

1. Information taxonomy. Initial versions of the research on structuring thought referred to here, and its subsequent embodiment in a life-cycle methodology for creating structured documents) was awarded the Diana Lifetime achievement award by the Association of Computing Machinery's SIGDOC (Special Interest Group on Documentation) in 2000.

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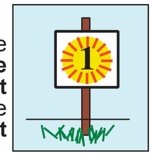
The One Million Stand-Alone (Hyperlinked) Diagrams and Info-Murals Displayed on Large Interactive Wall Project

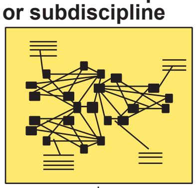
could be considered the **First Milestone** in the **Visual Language Project** and the **Human Cognome Project**

First Milestone

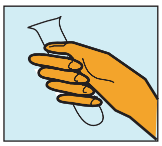


has several **goals** including

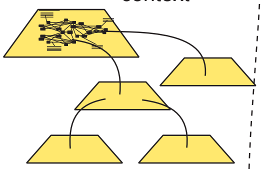
create a collection of **stand-alone diagrams and info-murals** for an **entire discipline or subdiscipline**



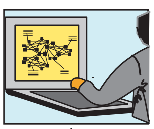
such as major subfields of **biotechnology, nanotechnology,** and/ or perhaps **ethnic conflict and terrorism**



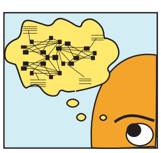
that are **linked into layers** so that they can be **navigated by zooming** to detail and wider context

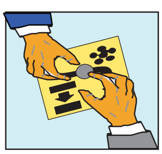


that would the enable researchers, teachers, and students to carry around in their laptop computers **a complete navagatable subject matter** displayed in easily modifiable **stand-alone diagrammatic form** linked together in easily accessible, indexed **levels**



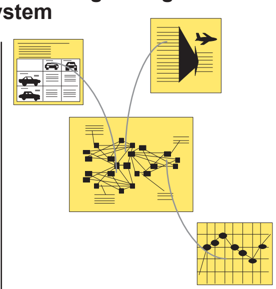
that would enable researchers from other fields to more easily understand the frontiers of the field and hence to **borrow, exchange and contribute concepts, techniques, theories**



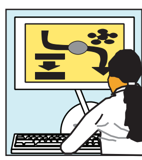


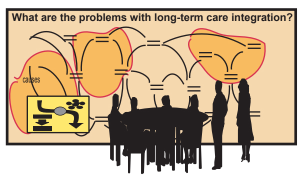
and thus become **an essential tool for progress** in the **frontiers** of **science**

create a detailed, comprehensive analysis of the **structure, components, organization, and relationships** of ***every* major kind of diagraming system**

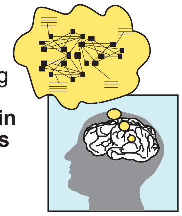


which would the lead to the ability to ***create*** diagraming and info-mural ***software tools*** that would enable researchers and learners to easily create and rapidly modify diagrams and info-murals for educational and communication purposes and displayed for individual work and group problem solving and innovation on large interactive wall-size displays

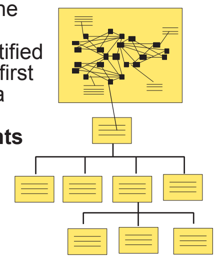




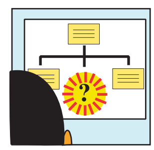
begin to create a systematic understanding of ***how*** the **best human thinking in advanced subject matters** takes place



because **every element** of the diagrams would have been identified and cataloged into a first approximation of a **taxonomy of thought components**



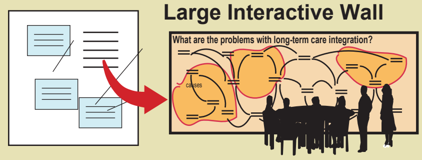
and where the project runs into difficulties accomplishing this goal, these **gaps, ambiguities,** and **intractabilities** can be **addressed explicitly,** thereby creating the conditions for understanding them.



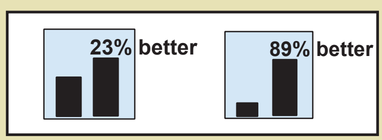
Stand-alone diagrams and info-murals

can be **defined as** diagrams for which the explanatory text is tightly integrated within the diagram space itself, ***not separate from it.***

Large Interactive Wall



The **importance** of such diagrams is that tight integration of words and images produces **improvements in learning scores** (by 20 to 89%) and **speeds learning** (by up to 20%).



Mayer, Richard E. 2001, *Multimedia Learning,* Cambridge, Cambridge University Press

Links: Stand-alone Diagrams

Diagram Type: Talkiing Tree

2024
Case Study of Mess Mapping

by Robert E. Horn

A chapter "Case Study of Mess Mapping Process: Improving Long Term Care Services " in Mari Suoheimo, Sheng-Hung Lee, Birger Sevaldson, and Peter Jones (2024) *Systemic Service Design,* Routledge (in press)

Case Study of Mess Mapping Process
Improving Long Term Care Services

A chapter for Mari Suoheimo, Sheng-Hung Lee, Birger Sevaldson, and Peter Jones (2024) *Systemic Service Design*, Routledge (in press)

Robert E. Horn

The concept of "social messes"

Social messes
Often we do not seem to be making progress on our so-called social and political problems. The main idea of this article is that this is because we misconceive them. And the way we represent them to ourselves is a direct result of our way of thinking about them. Too often our academic analysts, media observers, and politicians have ignored the deep difficulties that a whole series of inter-related problems presents to society. The task forces and committees we assign solve our problems rarely start by understanding the mess they have found themselves in. Instead, they often superficially analyze a few of the causes and costs of the "problem" and immediately move to formulating recommendation. If we are to make any progress, we need to be far more modest about our understanding of the looming issues we face. We need to start thinking about a great deal of our world as a collection of social messes.

What is a social mess?
Russell Ackoff originated the concept of a mess. He says: "We have also come to realize that no problem ever exists in complete isolation. Every problem interacts with other problems and is therefore part of ***a set of interrelated problems, a system of problems***. For example, the race problem, the poverty problem, the urban problem, and the crime problem, to mention but a few, are clearly interrelated. Furthermore, solutions to most problems produce other problems; for example, buying a car may solve a transportation problem but it may also create a need for a garage, a financial problem, a maintenance problem, and conflict among family members for its use. English does not contain a suitable word for 'system of problems.' Therefore, I have had to coin one. I choose to call such a system a *mess*." (Ackoff, 1974, 20-21)

They've been called "wicked problems" (by Horst Rittle), "ill-structured problems," (by Ian Mitroff). I call them "social messes" (after Russell Ackoff, who simply refers to them as "messes"). What they are ***not*** is merely "problems." Problems have solutions. Social messes do not have straightforward "solutions." (Sometimes they have resolutions or "progress" is made on them.)

Social Messes **(Synonyms: Wicked Problems; Ill-Structured Problems; Messes)**

Social messes are those systemically inter-related problems about which different people have very different perceptions and values concerning their nature, their causes, their boundaries, and their solutions. They are the problems that immediately bring out at least two or more points of view at their first mention.

Characteristics of social messes

Most messes are interconnected to other messes and to lesser problems. Data about them are often, partial, uncertain, ambiguous, or missing (and sometimes downright wrong). Since different views of problems and solutions are contradictory, there are many contradictory intervention points as well. Risk is often difficult or impossible to calculate, and therefore, consequences of different action plans are difficult to imagine and assess.

Social messes, thus, have these principal characteristics:

- complicated, complex, and ambiguous
- much uncertainty, even as to what the "problems" are, let alone what the "solutions" might be
- great constraints
- tightly interconnected, economically, socially, politically, technologically
- seen differently from different points of view, and quite different worldviews
- contain many value conflicts
- are often a-logical or illogical.

Example of public messes

Messes represent the context in which business and government strategies are made. They are the underlying situations that produce what we call the uncertainties and risks involved in business and government strategy. Figure 1. is a simple systems diagram of a mess.

Figure 1. Simple system diagram of a mess.

You can start anywhere in it and go anywhere in it. Start, for example, looking at the inner city in America, the connection with drug gangs, which connect to the US governments' war on drugs – a very expensive proposition, which connects to the country of Columbia, where the drug is growing, and the war on the Mexican border that has cost 20,000 lives in the last few years – and Afghanistan, a major supplier of heroin.

How do we name such a mess? I call it sometimes the inner-city-drug-war-drug-gangs-drop-out-rate-unemployment-prison-guards-Mexico-Columbia-Afghanistan mess. But naming really isn't the most important issue.

Some of our messes have been in existence for a long time. Poverty and global warming, for example. Other messes, such as nuclear weapons, ocean acidification, cybercrime and cyberterrorism are more recent.

Needed: new processes for social messes

We need to develop some better processes and tools for dealing with our messes. They are very complex, so we need new concepts, new representational tools, new group processes, and perhaps new software to support these other endeavors. I will outline the

progress we've made in these areas.

New concepts

I have already introduced the key first concept, Ackoff's idea of a mess as an inter-related group of problems and other messes.

Ackoff introduces the idea by suggesting this background: "In the Machine Age problems were thought of as 'out there,' as purely objective states of affairs. But John Dewey, the great American philosopher challenged this notion and argued that decision makers have to extract problems from the situations in which they find themselves. They do so, he said, by the situation. Hence problems are products of thought acting on environments; they are elements of problematic situations that are abstracted from these situations by analysis. What we experience, therefore, are problematic situations, not problems which, like atoms and cells, are conceptual constructs."

Beyond this initial concept, other challenges we must address: the idea that we cannot identify precisely the boundaries of the problems; that we will have to proceed in a partial fog and that we are not going to be able to ultimately eliminate the fog from obscuring parts of the different problem areas that comprise the mess. We need to embrace the relatively recent flourishing of the idea that we need groups of people with very different backgrounds and perspectives and experience to help us analyze the messes. We need to deeply understand that no one – repeat no one – has anything approaching a complete idea of these social messes. Crucially, we need to be able to provide the group addressing them with representations (we call them "mess maps") that is help them group create ***common mental models*** of the mess.

The mess mapping process

In our group processes, high-level directors experiencing the mess for their organizations are usually gathered for a series of half-day meetings. They are identified and selected by the usually political leaders who are experiencing their own version of the stuckness of some of the organizations and processes they control.

Once assembled, the directors are asked to discuss the mess each from their standpoint, which is how their organization or group is suffering as a result of one or more of the interrelated problems. Usually, consultants or recorders develop a visual representation of these descriptions of inter-related problems on a template of a mess map. These notes are then synthesized, printed, and brought back to the executives for editing and interlinking. This is a general explanation. As you will see, the details are very important and distinguish the mass mapping process from many other group processes.

Several of these mess mapping processes have been conducted for service delivery organizations on the county level. Following is one such mess mapping process and project.

The Alameda Long Term Care Case
Alameda county is located directly across the bay from San Francisco. It contains approximately 1.5 million people.

In 2001, I was contacted by an organizational development (OD) consultant whose project was to improve the delivery of services to the elderly and disabled in the county. They had tried, without success, a number of methodologies over several years to move forward. It had been suggested that a mess mapping process might provide help.

Step one
Working with the OD consultant, we created a rough visual template of the organizations involved on a large table size (24 x 36 inches) piece of paper. Figure 2 is an example of template.

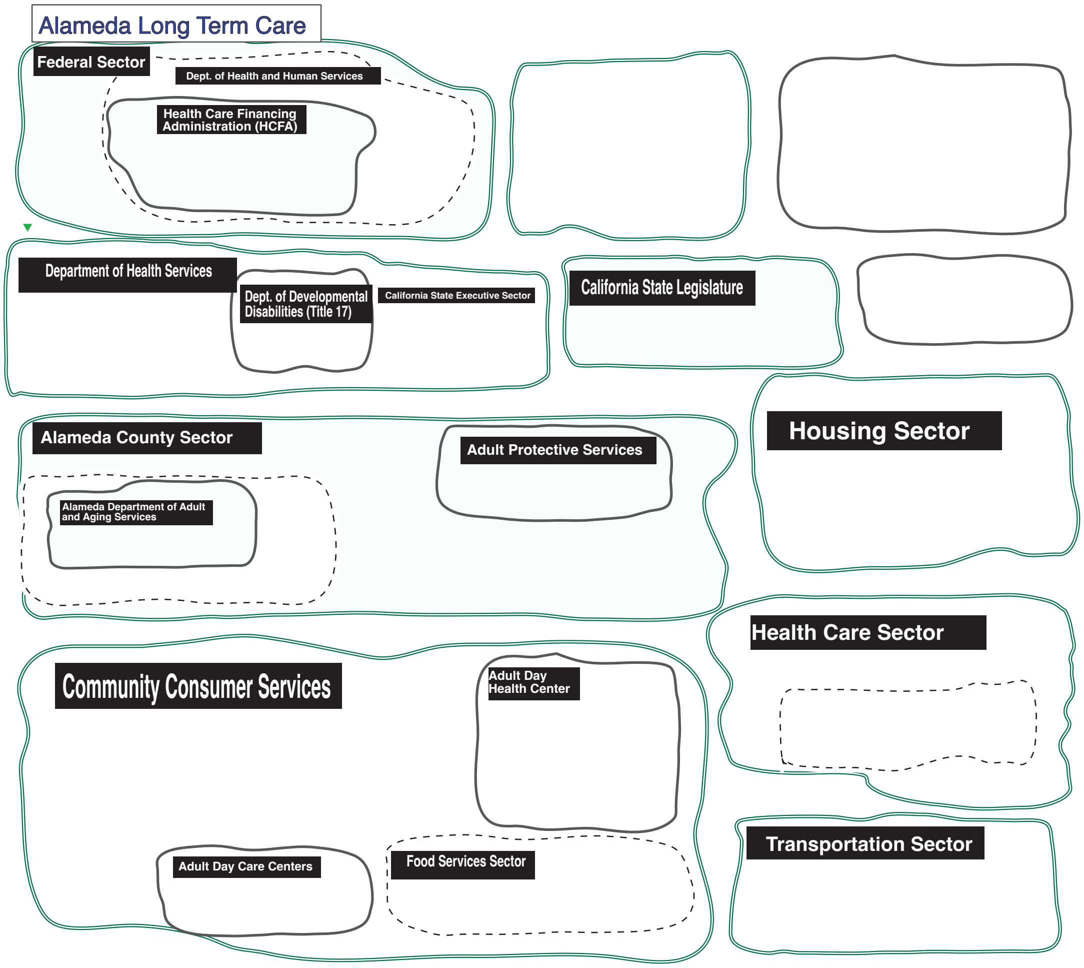


Figure 2. Example of a template.

First task force meeting

Approximately 15 directors or deputy directors of the organizations involved in delivering services to the elderly and disabled in the county, were assembled for the first half-day meeting.

They were divided into smaller sub-groups at tables with three to five people. I pointed out the sectors and organizations on the template and ask them to create to describe how their organization was experiencing the mess. *How was it painful for them* organizations? Our assumption was that the best way to identify a problem is by the person organization experiencing the pain. They then spent about three hours, adding to our template descriptions of how the problems were seen *from their point of view*.

We had recorders at each of the tables to write down how they described their suffering…their problems. Recorders assemble their notes at the end of the meeting into single visualization.

In between the half-day meetings, we then created the initial draft of the mess map on a computer. We used computer visualization software to enable us to subsequently modify and improve the map in successive version as we asked in subsequent half-day meetings of the directors.

Second task force meeting
In the second meeting, we handed out new printed versions of the draft mess map and divided the task force again into table size sub-groups again. We asked them to edit and change and correct the problem boxes. We asked if our recorders had correctly captured the pain of each organization correctly. Was there anything directors wanted to add?

We then asked them to describe *what is holding the problems in place*? In other words, identify the causes of the problems. This was our way of beginning to identify and represent the systematic inner relationships of the problems, as perceived by the directors. The recorders wrote down what the causes mentioned.

Here the directors had to specify what phenomena or structures were holding their problems in place. These often were policies, regulations, or laws that exist outside the boundaries of the organization experiencing the problem or pain. That is to emphasize that the causes holding the problems in place came from other organizations across the boundaries. Or they were customary habits, or behaviors of organizations– other than their own–over, which they had no control. In one sense having too many phenomena, behaviors, or structures that caused pain, was the context of many of the organizations involved in the mess mapping process.

The recorders, also added arrows, meaning influences or causes, between the problems, and the descriptions of the events and phenomena they had identified as holding the problems in place.

Subsequent, task force meetings
The identification of these causes and their discussion in the groups and their representation on the prototype mess maps took an additional two half-day sessions of the meetings.

Our recorders continued to take notes and we continued to add and integrate them to improved version of the emerging mess map on the computer.

Directors were also provided with copies of these improved printed versions of the maps, so that they could take them back to their organizations to gather more information and share with their staffs what they were doing.

Phenomena, structures, societal habits, behavior of others
Not surprisingly many of the problems were caused by multiple factors. We did not attempt to obtain any kind of consensus on the major causes. Initially, they were often obvious to the participant directors. But also, it had been necessary,

sometimes to resist the proliferation of causes, while still trying to unravel the tangle of causality in the mess. Facilitators would sometimes push back on task force members with the question: *Is it really an important cause? Is that what is really keeping the problem in place?*

From inside the blobs many problems are identified or expressed by "We can't do that because we depend on permissions, funds, timely information, referrals, resources, vetoes, etc. from other organizations across the boundary of our silo.

The final mess map

Figure 3. is the final version of the mess map.

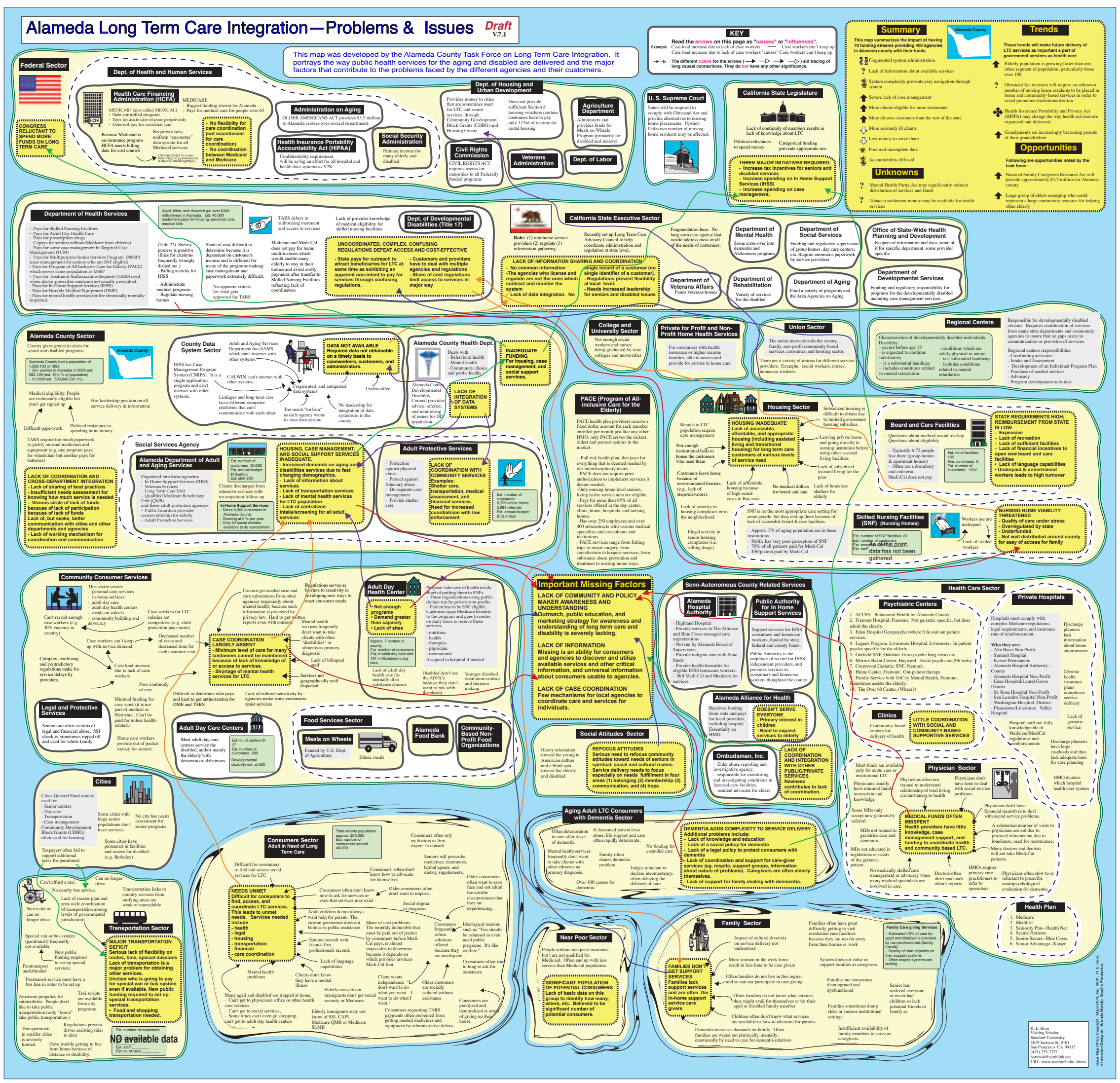


Figure 3. The Alameda Mess Map.

The final map and the recommendations of the test scores were presented to the county commissioners in a public session. One of the commissioners thanked the

task force for not producing another 80-page report that he had to read. And the commissioners were happy that the recommendations did not involve the appropriation of new funds.

Visual Components of the map

Here we pause to look at how specific kinds of elements have been presented visually on the mess maps.

Blobs—for major organizations or sectors involved in the mess
The prototype template presented to the participants on their small tables at the beginning of the mess mapping process are composed of blobs. One of the interesting things we've found in dealing with these groups is that attempting to create engineering-like diagrams with carefully drawn boxes, is something the participants do *not* like. They always get a chuckle when the facilitator tells them all they have to do is put their problems into blobs.

Phenomena, rules, law, structure, behavior
The various contributors to holding the problem employees are written out in short phrases or sentences contained in the blobs. Figure 4 is an detailed example of a blob and problem box.

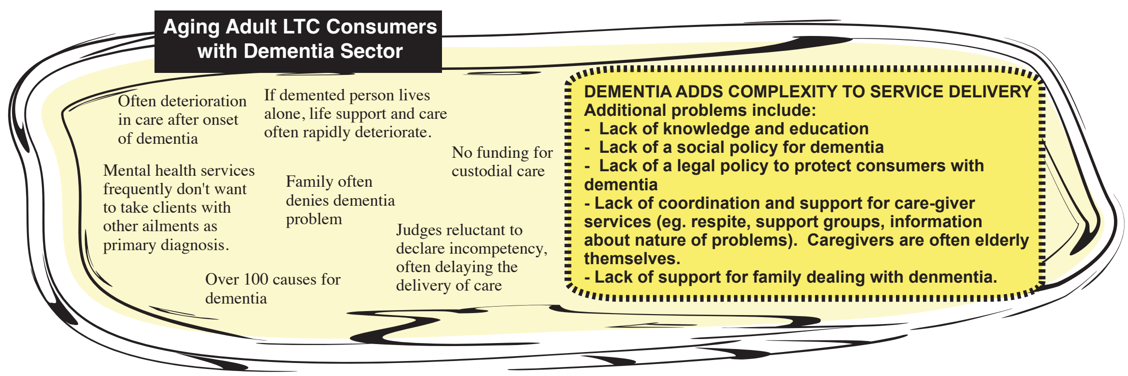


Figure 4. Example of detail of a mess map showing a sector blob and a problem box.

Problem boxes
Within the blobs, we do eventually outline carefully the problems after the participants have been working together for a while and are comfortable with the visualizations. Yellow is used to highlight that what we are doing in the mess mapping process is interlinking visually the problems that are expressed by the participants.

Example of problem boxes
Transportation sector
Serious lack of flexibility on route time and special missions.
Lack of transportation is a major problem for obtaining other services.

Unclear who is going to pay for a special van or bus system, even if available. New public funding required to set up special transportation services.
Food and shopping transportation needed.

Alameda Department of adult and aging services
Lack of information about services.
Lack of mental health services for Long term care population.
Lack of centralized intake and screening for all adult services.

Other data
If a mess, is to be shared with larger groups who have not been involved in the creation process, it is sometimes important to include show explanatory, definitions, or other information and data that will help these groups.

Different perspectives
One of the general rules of diagramming or visualization is that you should not put too much into a single diagram if you want people from outside of your creation team to use the diagram. This requires different visualizations with different perspectives. In the Alameda case, one of the perspectives that was identified in the group meetings was that funding was coming from multiple levels government in silos. This was complicated enough to require a separate visualization illustrated in Figure 5.

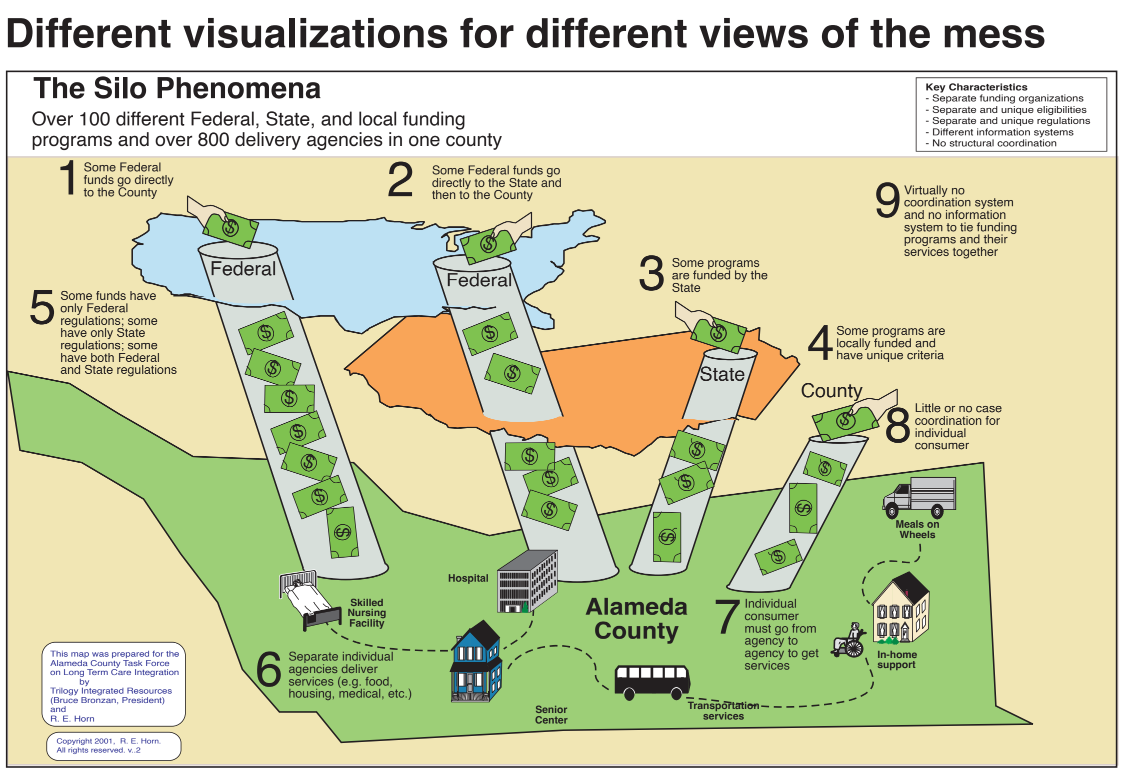


Figure 5. Example of different view of one aspect of the Alemeda mess.

Some concepts brought together in a novel way

Looking back at what we have done over a half dozen mess mapping processes we can see that putting together some old concepts, and some relatively new ones produce useful ways of working through messes.

A new group process for capturing expertise

The mess mapping process is a way to provide the input to a process for more efficiently and effectively capturing and synthesizing group expertise early in a task group project. It is based on the assumption that *multidisciplinary task groups need special forms of group process for them to use well the expertise assembled*. Too often such groups try to lecture to each other and nearly everybody in such a group of smart people has already come with "solutions" to the problem. This interferes with deeper exploration of the mess, as well as often preventing creative exchange. The use of the concept of a "mess' as an interrelated set of problems breaks that initial set and challenges the experts to work together to produce an analysis they wouldn't have produced by themselves or in a conventional group process to focus on structure function and solutions. This reframing changes their motivation from displaying their expertise to involvement in exploring new territory together.

Both the use of the physical metaphor of a "map" also intrigues them and the abstract concept of a mess, intrigues, and reframes the task groups. It draws on their experiences of navigating in new territory as well as in the process of constructing the map which changes significantly over several sessions.

Avoids, single answer, and single root cause

Too many task groups want THE answer. Too many are looking for a singular root cause. The mess reframing helps avoid these pressures in groups.

Enables a different kind of listening

A second idea is that the visualization or mess map enables the participants to listen to each other suffering and to incorporate the causal in the linkages of this suffering to their idea of problems. They listen in a different way. Creating a mess map together, enables them to begin collaborating and understanding that: "*I am creating your problems and you are creating my problems*." This is visually represented on the maps as well. Mess mapping focuses on better understanding the situation that the organizations together create.

Different understanding of causality

Among the concepts used in mess mapping is a different and relatively new idea of causality: what is holding the problem in place? This is labels, sometimes the test groups to imagine other ways of relieving the suffering.

One of the interesting and novel ideas that appeared in the creation of the mapping mess process. What is the idea that problems with disappear if they were not one or more causes keeping them in place so that was one of the criteria for problems. Did they caused pain to a person or an organization and were there causes holding them in place?

Causes are largely anthropogenic

Messi mapping process is we often see that the causes are largely anthropogenic. We cause many of our own problems by the way we generate our systems, by our rules, our boundaries, our fears, our budgets, our bureaucratic turf behavior, and our empire building.

Different levels of analysis for social messes lead to different levels of map detail

Messes can be analyzed and described at different levels of focus. For example, we have helped county task forces on mental health, long term care of the elderly, and national and international task forces to address their messes. Figure 6 is an example showing potential levels of mess maps of the long-term care issue.

Levels of Mess Maps

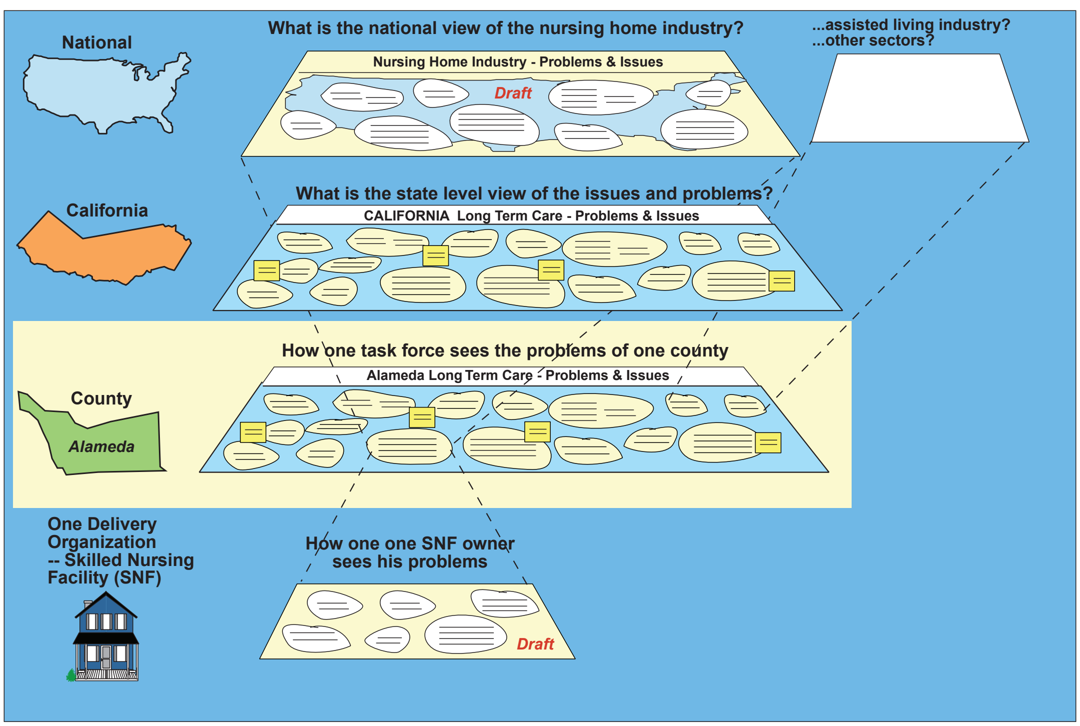


Figure 6. Visualization of possible mess maps at different levels of

Feelings of ownership of the product of the group process

Working together enables the task group over time to take considerable ownership in the product. Working together also gives the experience of shared expertise of group mind,

especially since the facilitator continually emphasizes that what we are after here is a "common mental model" of the mess.

The effect of the blobs and messes nomenclature and graphic form

The concept of a "mess" also allows the experts to let down their guard and more fully participate. The deliberate use of "blobs" as the major visual element loosens the expert's drive to be overly precise in a situation where excessive precision is generally not called for.

The facilitator normally emphasizes that blobs are easier to work with than rectangles. Blobs are not so demanding as neat and tidy rectangles. Curved and loopy arrows add to the messiness of the drawings. The curvy arrows and blobs ensure that mess maps do not remind participants of engineering drawings.

Blobs also introduce an element of playfulness in situations of considerable seriousness which most of the task groups are addressing. It is well known that playfulness aids creativity, both in individuals and in groups.

No final report

One of the interesting things about the working groups that have created Mess Maps is that *they did not write final narrative reports*, reports that they strongly suspected would not be read. They felt their maps and scenarios were the best representation of the issues and so they gave the maps and scenarios themselves to key decision-makers and authorities as their report. For recommendations, the Alameda task force created another visualization shown as Figure 7.

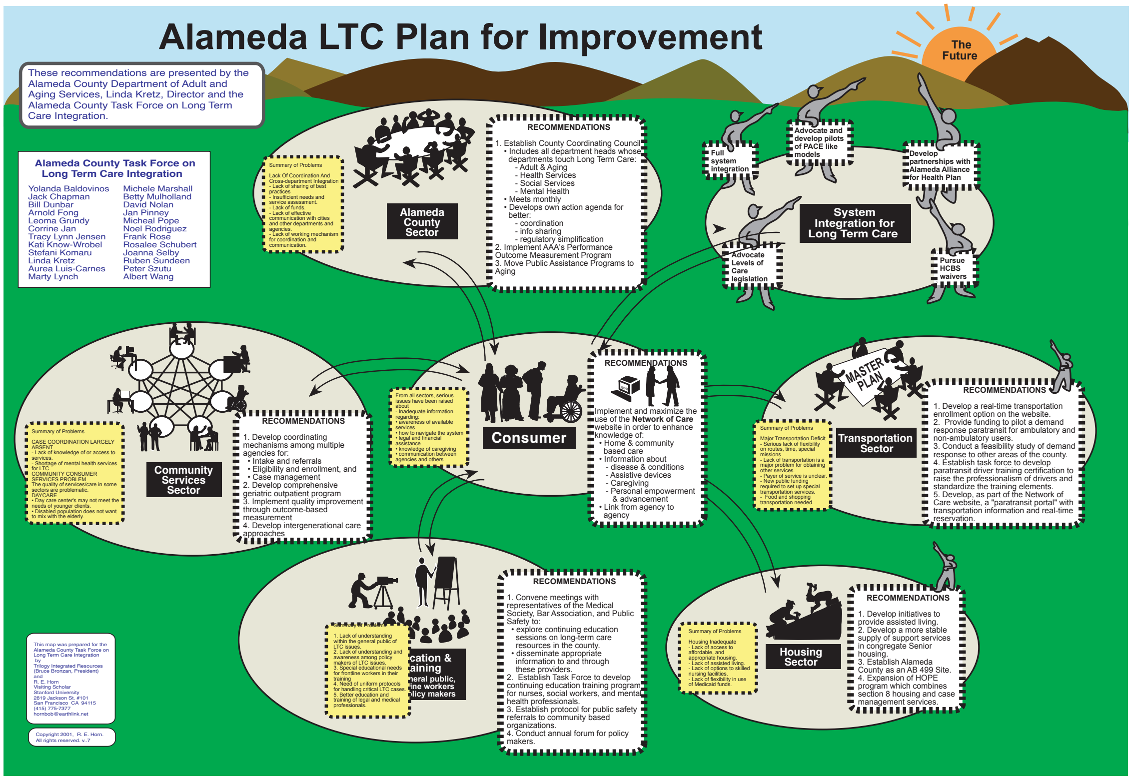


Figure 7. Final report of the Alameda mess project as presented to the Supervisors of the county.

Social Learning Processes

We view the use of Mess Maps as important new social learning capabilities for communities and organizations to work through their messy problems. Other small group, task force processes, they are inherently opportunities for social learning because the messes we face must be dealt with together. Every member of a task group has something to contribute. It is only when we learn together, and only when we can begin to represent concretely our common understandings that we can make rapid progress with our social messes. Only through group processes that facilitate social learning can working groups begin to untangle one or another of the several messes that affect our individual and collective lives.

Different approach to exploring frontiers

Mess maps can be used in other ways that we have illustrated with the Alameda case. For example, in 2005, we used a mess mapping exercise as one of the interactive processes in the **PanDefense 1.0** conference that was held to put Avian Flu on the public agenda. We used the process to help the group contribute their expertise to elaborating aspects of the mess that had not already been identified in the scientific literature. In this way it was a "stage setting" exercise to help the conferees move on to the major goals of the conference: (1) to focus on increasing public policy awareness of an Avian Flu Pandemic, and (2) to identify gaps in what was being done to prepare for that possibility.

What to do after a mass map process is completed?

A further phase usually follows the mess mapping phase of a task force group and may involve a number of standard organizational interventions. I will describe a few of the ones we have used. But I want to emphasize that it is very important to keep the mess mapping, separate and distinct from the "what to do about the mess phase."

I've emphasized that mess mapping is a way for task groups to get into their issues. It is an initial stage process. It enables groups to get started, to form common mental models is the issues, to learn about each other, and to quickly achieve clarity about the interrelated set of problems they face.

Because working groups typically make recommendations on the basis of their study, they have to focus on the network of forces that are creating and maintaining the messes while at the same time impeding their resolution. And because these causes often *cross boundaries* of existing sectors and organizations, the initial formal name for Mess Maps was "cross boundary causality maps."

But what happens after the mapping? The short answer is "It depends." Different task groups with different missions make progress using quite different next steps. I'll talk about each of them. Please note that any of these next steps can be combined in a single project.

1. **Focus on creating solutions to the multiple problems identified -- all at once**

One of the most difficult problems that surfaced from the mess mapping exercise was the difficulty of identifying changes that could be made without requiring new legislation to change the entire structure. This was a very difficult problem.

In the Mess Map we made with the Alameda Long Term Care Integration Task Force we had the team brainstorm solutions to the approx. 30 problem boxes in an hour and a half. We set a time limit of a maximum of four minutes per problem-solution brainstorm segment for each identified problem. The task force came up with a complete set of recommendations to the county supervisors who had appointed them.

2. **Use the Mess Map as the centerpiece of an organization-wide dialog**

We did a mess mapping process for the health insurance organization of the Methodist Church. They were struggling with the question of why Methodist ministers were among the least healthy of all professionals in the U.S. After creating a mess map that looked like this with their nation-wide task force, they decided to use the map as a tool around which dialogs about the mess could be conducted in congregations across the country. This would lay the groundwork for a wider organizational discussion about changes that needed to be made in the church's structure and organization.

After the ness mapping process what is completed, another task force was formed and worked for a year and a half -- deepening their understanding of the issues and taking the mess map back to their home congregations and organizations to ponder the meaning of it before coming up with recommendations. This very large dialog throughout multiple levels of the church has produced a set of recommendations for organizational change. What was important the process was the reframing of the mess, not one about insurance or the clergy, but about organizational and systemic issues that needed restructuring. Helped start a process of a church-wide study that is resulting in major changes in how the church (of 10 million members) organizes itself.

3. **Move on to a scenario planning process to suggest ways of resolving the messes**

Another way of taking what has been learned in Mess Mapping for groups involved in thinking strategically, is to use a scenario planning exercise. It has to deeply involve the decisions makers who will be guiding and managing the multi-year strategy. It is one of the ways to begin to resolve -- not solve -- the social messes that we attempt to understand with the mess mapping process. Among the several scenario approaches possible, I prefer the one that provides several alternative scenarios that incorporate critical events supported by reasonable assumptions and portrayed visually. We have done this in our climate change and energy security work.

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